FOUNDRY TRADE JOURNAL

EST. 1902

WITH WHICH IS INCORPORATED THE IRON AND STEEL TRADES JOURNAL

VOL. 99
No. 2029
Registered at the G.P.O. as a Newspaper

JULY 21, 1955
Offices: John Adam House, John Adam St., London, W.C.2

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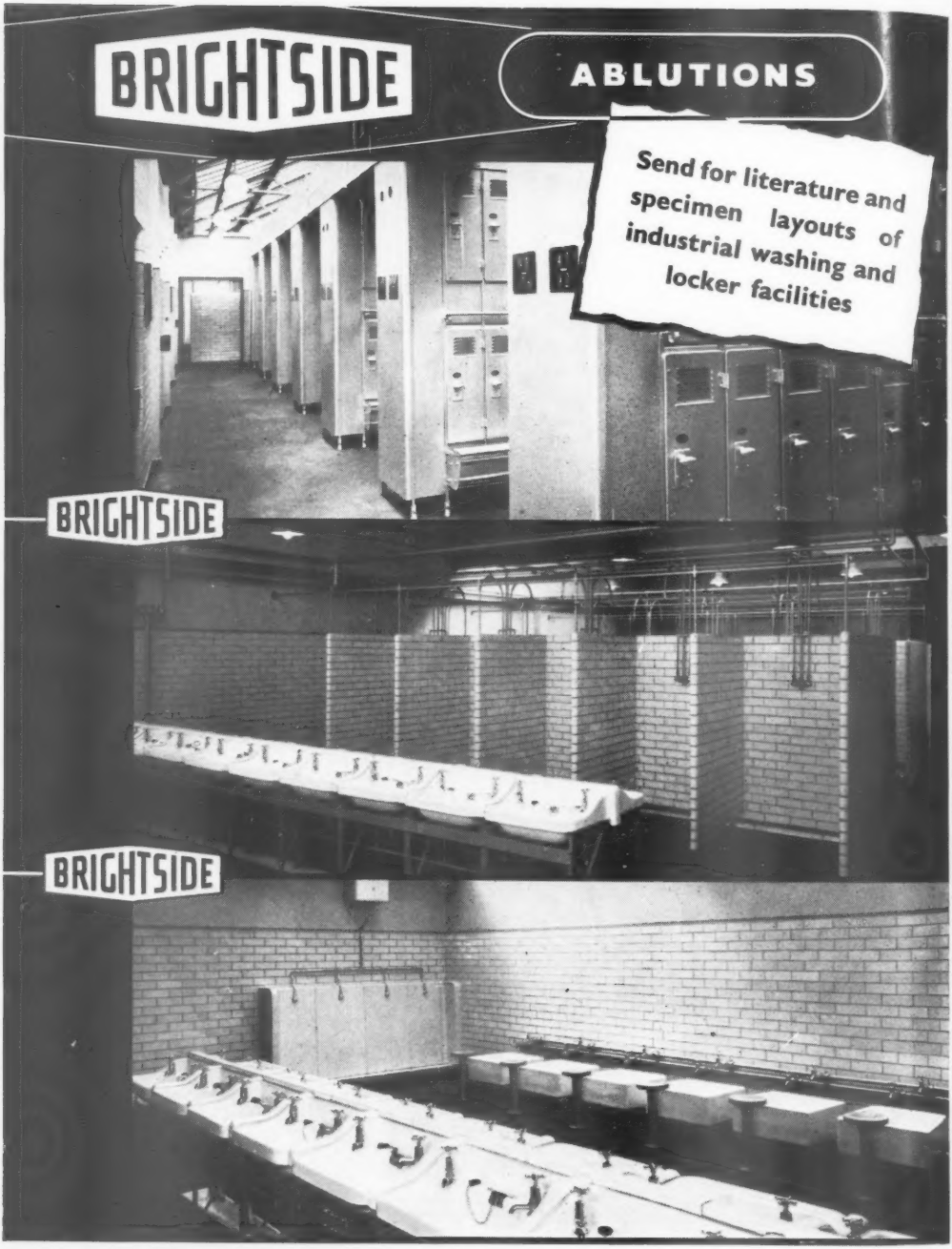

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FOUNDRY TRADE JOURNAL

Established 1902

Vol. 99 | Thursday, July 21, 1955 | No. 2029

Editor:
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AN INDUSTRIAL NEWSPAPERS PUBLICATION

Published Weekly

Single copy 9d.; by post 11d.
Annual subscription : home 40s., abroad 45s. (prepaid).

JOHN ADAM HOUSE, ADELPHI, LONDON, W.C.2
'Phone: TRAfalgar 6171 (10 lines)
'Grams: Zacatecas, Rand. London.

Interesting Developments

We have recently found time to look into foreign foundry literature in a search for novel developments. The first of outstanding interest is a paper presented to the recent Texas meeting of the American Foundrymen's Society, by Mr. H. H. Hursen, covering the production of steel wheels for railway wagons by forcing the liquid metal under pressure into graphite permanent moulds. Unlike this country, the Americans have for years used chilled-iron wheels for railway wagons, but more recently, the loading and speeds have become greater and the braking more severe. Graphite moulds, it is stated, will not withstand top pouring, so that a system has been devised for filling the mould from the bottom through a refractory tube, using compressed air at 22 lb. per sq. in. as the means for accomplishing this. The wheels weigh 750 lb. as cast and in five minutes after pouring they are solid and are stripped.

A second development which came within our purview appeared in *Die Giesserei*, the German foundry magazine. It told of the availability of low-ash (3 per cent.) high-density coke, which gave outstanding results as a fuel for the cupola. It is the outcome of an American innovation —"Densite Coke." Here indeed is a development which must be watched by British founders and if they are satisfied as to its merits, then pressure must be brought to bear on the coke industry to see that this country does not lose its competitive power in the export market, because of the non-availability of a superior fuel for melting.

Returning to America, there has been a series of articles on injection methods as applied to foundry practice. These have been entitled "Increasing Carbon Content of Cast Irons by Ladle Injection" by Mr. G. E. Spangler and Mr. R. Schneidewind. The latter has also collaborated with Mr. J. W. Estes in a paper on "New High-strength Cast Irons Produced by Injection Methods" and with Mr. John A. De Haff in one on "Calcium-carbide Desulphurization by the Injection Process." The fourth one is "Fluidization—Injection Process in Desulphurizing and Upgrading Cast Iron." In all these cases, the material used was injected below the surface of the molten metal, usually employing an inert gas—normally nitrogen—as a carrier. The results reported are very promising, without being spectacular. The process should have the attention of the research laboratories in this country.

Turning over many papers from abroad, most of them are of an evolutionary character and each adds a modicum of knowledge to the general pool. A development of a revolutionary character in foundry practice is a *rara avis* in these days, but in recent years, quite a number of such developments have made their appearance.

Congress Paper Authors

Dr. J. White, joint Author of Part II of the Paper "Metal and Mould Research on Steel Castings" printed on page 59 of this issue, was born at Langholm, Dumfriesshire, and was educated at Langholm Academy, Dumfries Academy, and Glasgow University, where he graduated B.Sc., with first-class honours in Physical Chemistry in 1931. The same year he entered the Royal Technical College, Glasgow, with a research scholarship in metallurgy, awarded by the Department of Scientific and Industrial Research, and later became research assistant to Prof. R. Hay in the Metallurgy Department, and then lecturer in metallurgy in the College. In 1934, he was awarded Associateship of the College in Metallurgy and in 1935 the degree of Ph.D. of Glasgow University. In 1939 the Carnegie Gold Medal of the Iron & Steel Institute for Research was conferred on him and he graduated D.Sc. (Glasgow). In 1943 he left Glasgow to become research technologist with General Refractories, Limited, at Worksop. In 1946, he was appointed lecturer in refractory materials at Sheffield University, and in 1952 was elected a fellow of the Institution of Metallurgists, and in the same year had the title of Reader in Ceramics conferred on him by Sheffield University.

Mr. J. M. Middleton, joint Author with Dr. White, is the senior investigator of the foundry process division of the British Steel Castings Research Association. He was educated at Sheffield University, and became Associate in Metallurgy in 1937 and an Associate of the Institution of Metallurgists in 1952. From 1940-47 he was an investigator for the Ministry of Supply on Armament Research. He joined the steel castings division of the British Iron & Steel Research Association in 1947 and transferred on its formation in 1951 to the research and development division of the British Steel Founders' Association which is now the British Steel Castings Research Association. His investigations have included original work on hot-tearing in steel castings which has been the subject of published papers in this country and America.

IBF Congress Fund

In addition to the subscriptions to the Congress Fund of the Institute of British Foundrymen, published in the January 27, March 31, and May 26, 1955, issues of the JOURNAL, the following donations have been received:—

	£	s.	d.
Foundry Trades Equipment & Supplies Association, Limited (additional subscriptions, making a total of £300 18s.)	27	2	0
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The grand total of subscriptions to the Fund amounts to £5,661 15s. 0d.

CORONET TOOL COMPANY, manufacturers of woodturning and metal-spinning lathes, of Derby, featured a display of their products at the Ideal Homes Exhibition, Nottingham.

Luncheon

FOUNDRY COKE MERCHANTS' ASSOCIATION

Last Thursday, Mr. R. J. McDonald (McDonald Muter & Co.), the chairman, presided over the annual luncheon of the Foundry Coke Merchants' Association at the Waldorf Hotel, London. Also at the high table were Mr. C. B. Hardwick, Mr. C. F. Sullivan, Mr. A. Carr, Mr. J. Y. Feggetter, Mr. H. H. Prosser, Mr. J. J. Selby, Mr. W. Armstrong, Mr. F. Arnold Wilson and Mr. A. T. Fitter. The assembled company numbered about 60 members and guests.

In proposing the toast of "The Guests", Mr. McDonald mentioned the double postponement of the event, caused first by the general election and second by the rail strike, and said that this had caused the absence of Mr. R. H. E. Thomas (NCB) and Mr. Leslie O'Connor, president of the Coking Industry Association. He named Mr. J. Y. Feggetter as chief guest, and also welcomed other official guests and members' personal friends.

At the annual general meeting of the Association which followed the luncheon, Mr. McDonald was confirmed in office for a further period as national chairman, Mr. S. Owen as national secretary, Mr. A. Carr as vice-president and the three retiring members of council were all re-elected. The only change recorded in the list of officials was the election of Mr. W. Pratt (Crooke & Company, Limited) as chairman and Mr. Le Mare as secretary, respectively, of the London section of the Association.

Imports Duties Further Suspended

After consultation with the Iron and Steel Board about the supply position, Her Majesty's Government have decided to make a new Order affecting the temporary suspension of import duties on iron and steel. The Order prolongs the temporary suspension of import duties on cold-rolled steel sheet of a value of less than £80 per ton until September 18, 1956; and suspends until March 18, 1956, the import duties on a wide range of iron and steel products. The duty on most of these, including tinplate and tinned sheets, is already suspended until September 18, 1955. In order to ensure adequate supplies of ferro-manganese for the manufacture of steel in the United Kingdom, the Government have also decided to suspend the duty on blast-furnace ferro-manganese until March 18, 1956.

So as to ensure that imports of tinplate do not displace the output of the hand mills, the Government have obtained a renewed undertaking from the producers and the main consumers of tinplate, that all available home-produced tinplate, including the full output of the hand mills, will be taken up.

Copies of the new Order (S.I. 1031) may be obtained from H.M. Stationery Office or from any bookseller, price 3d. (by post 4½d.).

THE DEATH IS ANNOUNCED, following an operation, of MR. CLIFFORD EDGAR KEEY, who was financial director of Birmid Industries, Limited, Smethwick (Staffs), and of its associaited companies. Mr. Keey began his professional career with a firm of chartered accountants in Birmingham and later served with Guy Motors, Limited, Wolverhampton. He joined the Birmingham Aluminium Casting (1903) Company, Limited, one of the companies in the Birmid group, in 1927 as commercial manager and accountant. Mr. Keey was a member of the Light Metal Founders' Association.

Metal and Mould Research on Steel Castings

Part I.—Solidification Mechanism, By J. A. Reynolds, B.Sc., Ph.D., and A. Preece, M.Sc., F.I.M.

Part II.—Mould- and Core-bonding Agents, By J. M. Middleton, A.Met., A.I.M., and J. White, D.Sc., Ph.D., F.I.M.

(*Continued from page 38*)

The second part of the Paper opens with a description of tests carried out to determine the mineral classification of a bonding clay. The bonding properties, together with a "life" index of a number of bentonites from a wide variety of sources, are then compared, as also is a number of kaolinitic clays of British origin. While it is shown that the latter have inferior bonding properties as compared with the bentonites, mixtures of the two types of clay are indicated as offering certain advantages. Di-electric-cured and oven-baked resin-bonded cores are then compared, and their relative susceptibilities to moisture pick-up are investigated. The incidence of hot-tearing in steel castings is shown to be influenced, not only by the degree to which the mould is rammed, but also by the type and amount of bond employed in the moulding material.

Part II.—Mould- and Core-bonding Agents

Introduction

In part I of this Paper attention has been given to the relation between the factors governing the mode of freezing of the molten metal, of the subsequent cooling of the solid and the resultant structure, which according to its character may influence the final physical properties of the cast material. The temperature gradient in the casting is related to its mass and to the conditions at the interface between the metal and the mould. The properties of the mould are accordingly equally important in the determination of the final character of the casting. The factors which determine the character of the surface of the casting have been an important feature of the researches which have been sponsored by the British Steel Castings Research Association. Recent papers on the penetration of the metal into the mould surface and the subject of hot-tearing have appeared under the authorship of T. P. Hoar, D. V. Atterton and D. H. Houseman[10] and J. M. Middleton.[11]

In part II of this Paper attention has been more particularly devoted to systematic researches, which are cognate with the study of the features of foundry science mentioned above. Both surface-finish and hot-tearing are markedly influenced by the composition of the moulding material and especially by the type and composition of the bonding agent.

The bonding agents used in moulding sands are of two kinds, inorganic and organic, the latter being used primarily where a high degree of collapsibility is required, as in cores. Clays are, of course, the principal inorganic bonding-agents, while the organic bonds are generally compounded from drying oils (chiefly linseed oil) or synthetic resins and a cereal.

Paper from the British Steel Castings Research Association presented at the International Foundry Congress in London last month. Of the Authors, Dr. Reynolds and Mr. Middleton are associated with BSCRA, Mr. Preece is Professor of Metallurgy, King's College (University of Durham), Newcastle-upon-Tyne, and Dr. White is Reader in Refractories, University of Sheffield.

CONSTITUTION AND PROPERTIES OF BONDING CLAYS

All natural clays consist of two types of material, the essential clay mineral and the accessory—or impurity—minerals. Three principal types of clay mineral occur, *viz.*:

(1) The kaolinitic type, typified by the clay mineral of china-clay and most fireclays,

(2) The Montmorillonoid type, of which montmorillonite, the clay mineral in bentonites, is the most important member.

(3) Secondary micas, which occur in many shales, and as minor constituents of many fireclays and some ball-clays.

In all of these, the plate-like crystals are composed of layers of definite structure laid on top of each other like the cards in a pack, the unit layers, which repeat themselves through the crystal, being composed of sheets of oxygen ions, some of them combined with hydrogen to form OH groups, with the metal ions, aluminium, silicon, etc., situated between the sheets. In kaolinite, there are three such sheets with aluminium ions between one pair and silicon ions between the others, the sequence and relative proportions being O_3: Si_2: $O_2(OH)$: $Al_2(OH)_3$ giving the composition Al_2O_3, $2SiO_2$, $2H_2O$.

In montmorillonite, the unit layer consists of four oxygen sheets. In the "ideal" structure, typified by the talc-like mineral pyrophyllite, the sequence is O_3: Si_2: $O_2(OH)$: Al_2: $O_2(OH)$: Si_2: O_3 corresponding to Al_2O_3, $4SiO_2$, H_2O. In actual montmorillonites, partial substitution of aluminium and silicon by other ions occurs, the most important being Mg^{2} for Al^{3+} and Al^{3+} for Si^{4+}. Since in each case the substituting ion has a smaller charge

TABLE II.—*Chemical and Physical Properties of Bentonites.*

Chemical analysis.	(1) British.	(2) British.	(3) Austrian.	(4) Austrian.	(5) Germany.	(6) Germany.	(7) Hungary.	(8) Hungary.	(9) Italian.	(10) Italian.	(11) Greek.
Loss on ignition	9.79	7.45	6.52	7.12	14.72	9.25	—	—	5.73	8.87	4.72
SiO_2	56.56	57.08	70.27	70.35	50.78	55.72	—	—	70.24	63.10	71.70
TiO_2	0.75	0.50	0.22	0.32	0.36	0.21	—	—	0.22	0.22	0.24
Al_2O_3	14.58	15.70	16.88	12.92	17.90	21.96	n.d.	n.d.	15.10	15.04	15.58
Fe_2O_3	7.60	12.47	2.25	2.40	5.28	4.38	—	—	1.93	1.81	2.08
MnO	4.18	Tr.	0.07	Tr.	4.06	1.96	—	—	Tr.	Tr.	Tr.
CaO	3.31	1.62	2.85	3.74	6.04	Tr.	—	—	1.57	5.72	1.92
MgO	Tr.	4.69	1.16	1.94	Tr.	Tr.	—	—	2.81	2.03	1.60
K_2O	0.66	0.40	Tr.	0.20	0.71	0.72	—	—	0.46	0.22	0.21
Na_2	1.51	0.72	Tr.	0.97	0.18	2.22	—	—	1.71	2.27	1.74
SO_3	—	—	—	—	—	3.59	—	—	—	0.47	0.58
b.e.c. * ..	n.d.	70.3	76.18	65.8	69.16	71.60	—	—	70.9	58.36	48.20
pH in water ..	9.20	7.15 7.13	9.67 9.74	5.32	9.60	9.73	8.9 9.1	10.44 10.51	10.54 10.44	10.47 10.28	8.17 7.89
Gelling Index. †	non-gelling	non-gelling	non-gelling	non-gelling	non-gelling	non-gelling	non-gelling	20	25	16.7	non-gelling
Cone (cone fusion/down) (deg. C.)	1,250 bloated	1,350 b.oated	1,400 bloated	1,360	1,290 bloated	1,100 bloated	1,350	1,380	1,290	1,230	1,355
D.T.A. †											
(*a*)	140 s.	140 s.s.	115 s.s.	120 s.	125 s.s.	115 f.s.	135 s.	120 s.	135 s.	110 f.s.	115 s.s.
(*b*)	—	—	—	—	—	—	—	—	—	—	—
(*c*)	632 f.s.	538 f.s.	693 f.s.	689 f.s.	440 w.w. 665 w.	530 w.w. 670 w.w.	667 w.	550 w. 660 w.	704 f.s.	690 f.s.	681 w.
(*d*)	—	887 w.	946 w.w.	960 w.	900 w.w.	—	—	—	—	—	948.5 w.w.

* Base exchange capacity in milli-equiv. per 100-gm. clay.

† Differential thermal analysis peak temperature on deg. C.

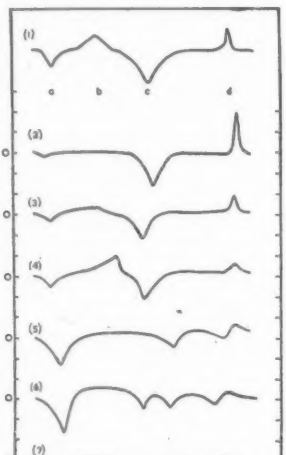

FIG. 11.—*Typical differential thermal-analysis curves of clays:* (1) *Hypothetical curve to show types of thermal peaks which may appear,* (*a*) *loss of hygroscopic moisture,* (*b*) *oxidation of organic matter,* (*c*) *loss of combined water and* (*d*) *crystallization of* $\delta - Al_2O_3$; (2) *china-clay;* (3) *ball-clay;* (4) *plastic fireclay;* (5) *bentonite with single combined-water peak;* (6) *bentonite with double combined-water peak; and* (7) *siliceous clay containing secondary-mica.*

than the ion substituted, this leaves the layer with a negative charge. To balance this, other positive metal ions occur between the layers. The latter attract moisture which enters the space between the layers causing the crystal to swell. The most important ions found in this position are sodium and calcium. A characteristic property of the sodium-montmorillonites is that when sufficient water is added, swelling continues until complete separation of the layers occurs. This enables them to form stiff gels at relatively small clay : water ratios.

Another feature of montmorillonites is that the interlayer ions can be replaced by others when the clay is leached with salt solutions. This is known as base exchange or ion exchange, and the base-exchange capacity is the number of milli-equivalents of exchangeable ions per 100 gm. of clay. With pure montmorillonite, the value is approximately 83 m.e per 100 gm. as against 2 or 3 m.e per 100 gm. for kaolinite.

In the mica-type clay-minerals, the unit layer also contains four oxygen sheets with a third of the oxygens in the two central sheets combined with hydrogen ions. In muscovite (ordinary mica) the sequence is the same as in pyrophyllite, except that one-quarter of the silicon ions are replaced by aluminium ions, while potassium ions occur in the interlayer spaces to balance the charges. Illites and hydrobiotites can be regarded as derived from mica by a process of alteration in which some of the potassium ions are removed while the number of OH groups is increased. The base-exchange capacity is of the order of 30-40 m.e. per 100 gm. Neither micas nor secondary micas swell in water.

The properties of clays depend largely on the clay mineral they contain, though they can be modified considerably by the accessory or impurity minerals. Kaolinitic clays as a group are characterized by high refractoriness (unless they are very impure) and relatively low bonding-power. The former property results from the high—alumina content of the kaolinite and low content of

TABLE II.—*continued.*

Chemical analysis.	(12) Greek.	(13) Cyprus.	(14) Spanish.	(15) Spanish.	(16) [North African.	(17) North African.	(18) Canada.	(19) Canada.	(20) Kenya.	(21) New Zealand.	(22) New Zealand.
Loss on Ignition ..	6.65	8.68	—	7.28	7.37	10.12	11.27	6.04	13.29	12.84	13.89
SiO_2	71.54	58.89	—	54.78	61.63	58.44	56.42	62.26	44.98	52.92	52.09
TiO_2	0.32	0.30	n.d.	0.40	0.40	Tr.	0.70	0.95	2.00	0.70	0.62
Al_2O_3	16.67	21.84	—	22.78	21.70	24.74	21.17	18.56	26.81	12.80	14.94
Fe_2O_3	1.33	3.10	—	4.76	3.17	2.18	4.63	8.14	3.14	5.43	3.43
MnO	1.00	Tr.	—	Tr.	Tr.	Tr.	1.91	1.80	6.18	11.44	11.41
CaO	2.45	1.80	—	3.74	2.48	2.42	2.73	1.34	2.46	1.59	0.74
MgO	Tr.	4.13	—	3.22	2.32	Tr.	Tr.	Tr.	Tr.	0.14	Tr.
K_2O	0.16	0.37	—	1.20	0.48	0.39	0.22	0.94	0.90	0.98	1.34
Na_2O	0.26	0.47	—	2.52	0.96	1.45	0.52	Nil	0.70	0.84	1.50
SO_3	0.19	—	—	—	—	—	—	—	—	—	—
b.e.c.* m.e. per 100 gm.	51.6	97.22	n.d.	59.22	63.14	86.82	95.27	58.2	65.52	48.76	55.32
pH in water	6.0	8.76	11.12	10.45	9.24	10.10	4.36	8.45	7.25	7.79	9.00
Gelling Index ..	non-gelling	non-gelling	25	20	14.3	16.7	non-gelling	non-gelling	non-gelling	non-gelling	non-gelling
Cone Fusion/Cone down) deg. C...	1,460	1,310	n.d.	1,220 bloated	1,240 bloated	1,340	1,330	133,0 bloated	1,190	1,225	1,210
D.T.A.†											
(*a*)	130 s.s.	145 s.s.	125 s.s.	135 s.s.	125 s.	135 s.s.	140 f.s.	110 s.	150 s.	110 s.s.	105 f.s.
(*b*)	—	—	—	—	—	—	—	—	—	—	—
(*c*)	690 f.s.	689 f.s.	535 w. 673 f.s.	600 w.	670 f.s.	517 w. 660 f.s.	390 f.s. 663 f.s.	527 w. 652 w.	522 f.s. 675 w.w.	546 w. 679 w.w. ‡795 s.	529 w. 676 w. ‡793 s.
(*d*)	910 f.s.	—	927 w.	900 w.w.	928 w.w.	910 w.	—	—	—	—	—

‡ 793 deg. C. and 795 deg.C. peaks due calcite. s = strong peak. w = weak peak. f.s. = fairly strong peak etc.

alkalis—lime, magnesia, and iron oxides. Compared to bentonites they have relatively low bonding-power. The ball-clays and plastic fireclays, however, are superior to china-clays in this respect. This is partly due to their small crystal size, but may also be related to difference in the structure of the crystals. Thus in many fireclays, and possibly in some ball-clays the " pack-of-cards " structure is disordered, in that the unit layers, though they are parallel to each other, have their crystallographic directions arranged randomly. Possibly because of this, ball-clays and many fire-clays appear to have their OH-groups less firmly held than do china-clays, and they lose their " combined water " at rather low temperatures than do the latter. It is also possible that this may be due to their small crystal size. Many of them contain appreciable amounts of secondary-mica clay particularly in their finer fractions.

Montmorillonites, on the other hand, because of their lower alumina content and higher content of alkalis (lime, magnesia, etc.) have relatively low fusion-points. They have, however, characteristically, the highest absorptive capacity and bonding power of all the bonding clays. Secondary micas, for the same reasons, have also relatively low fusion-points. They are considerably inferior to bentonites in bonding power, but are generally superior to kaolinitic clays in this respect, particularly as regards dry-strengths.

Testing of Bonding Clays

The scheme of testing employed by the Authors in the examination of bonding clays is one which has been devised to provide as much information as possible concerning the nature and properties of the clay by the use of purely routine methods of

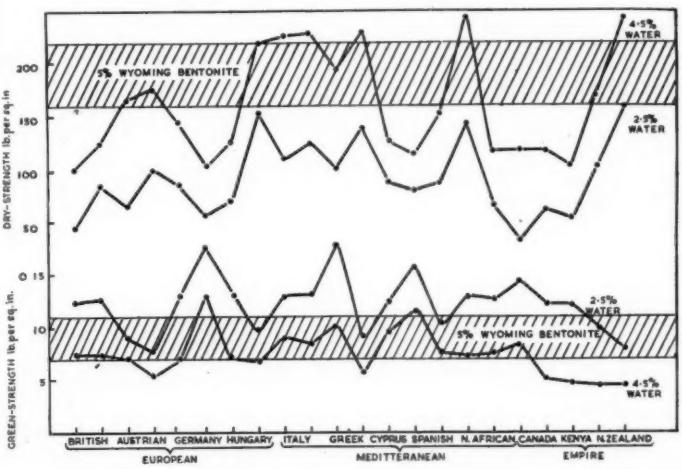

FIG. 12.—*Bonding properties of bentonites from various sources; (5 per cent. bentonite additions to Chelford sand; AFS test-pieces. 10 rams).*

Metal and Mould Research on Steel Castings—II

examination. The principal tests employed have been described by Davison and White,[12] and will not be detailed here. They are primarily chemical analysis, and the determination of cation exchange capacity, gelling index and fusion point, differential thermal-analysis, microscopic examination and tests of bonding characteristics as revealed by green- and dry-strength curves of mixtures of the clay with a silica sand of known characteristics. The significance of these tests will be clear from the foregoing, though some comment is perhaps desirable in the case of differential thermal-analysis.

Typical differential thermal-analysis curves of

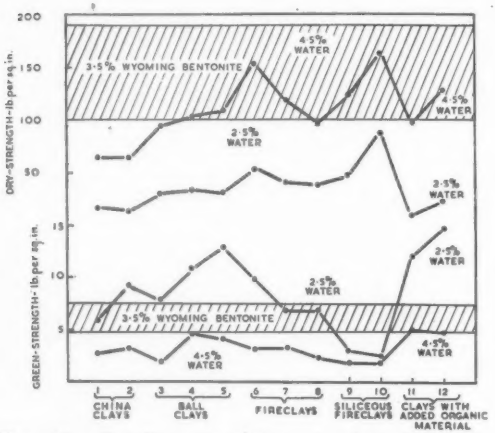

FIG. 13.—*Bonding properties of selected British kaolinitic clays. (7.5 per cent. clay additions to Chelford sand; AFS test-pieces, 10 rams.)*

kaolinitic clays, bentonites and a secondary-mica clay are shown in Fig. 11. The significance of the various thermal peaks which can occur is shown on curve (1) which is hypothetical. Perhaps the chief points to be noted are as follow:—

(1) The size of the hygroscopic moisture-peak (*a*), increases as the surface-area, absorptive-capacity and, in general, the bonding-power of the clay increases.

(2) The upper exothermic (heat-evolution) peak (*d*), increases from china-clay through the ball-clay and fireclay, and is generally small in the bentonites and secondary-micas. This disappearance is usually considered to be due to the presence of impurities, mainly alkalis, alkaline earths and iron oxides.

(3) The decomposition peak (*c*) of bentonites as typified on curve (5) is high compared to that of kaolinite, and the kaolinitic ball-clay and plastic-fireclay give lower peak-temperatures than do china-clay.[1] The double peak shown on the bentonite curve (6), which is of fairly frequent occurrence, might indicate that the clay was a mixture of montmorillonite and, *e.g.*, illite. There is evidence, however, that it can occur with true montmorillonite, and may be due to the presence of very small particles or to lattice substitutions. Davison and White[12] found that bentonites giving this type of curve tended to have low "life."

(4) The decomposition temperature of the secondary-mica clay curve (7) is comparable to that of fireclay.

Bonding Properties of Bentonites

Over a period of years, bentonites from many

TABLE III.—*Chemical and Physical Properties of Representative British Clays.*

	(1) China-clay.	(2) China-clay.	(3) Ball-clay.	(4) Ball-clay.	(5) Ball-clay.	(6) Fireclay.	(7) Fireclay.	(8) Fireclay.	(9) Siliceous clay.	(10) Siliceous clay.	(11) Ball-clay with organic addition.	(12) Fireclay with organic addition.
Loss on ignition ..	11.99	12.59	9.92	11.53	9.13	12.14	8.32	7.07	2.63	3.92	19.31	20.63
SiO_2	46.86	47.27	52.62	46.75	50.60	52.86	62.74	61.16	85.27	79.74	44.01	42.20
TiO_2	Tr.	Tr.	0.95	0.95	0.90	1.48	1.32	1.30	1.85	1.90	0.70	0.80
Al_2O_3 ..	38.59	38.38	30.74	38.10	33.58	28.95	22.86	25.48	8.74	12.56	30.65	32.36
Fe_2O_3 ..	0.59	0.32	1.22	2.25	2.08	1.84	1.53	0.92	0.98	1.28	1.44	0.66
MnO	Tr.	Tr.	Tr.	Tr.	Tr.	0.78	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.
CaO	0.47	0.08	0.83	0.61	0.83	0.52	0.17	0.50	0.20	0.39	0.39	0.59
MgO	0.64	0.27	0.47	Tr.	Tr.	Tr.	0.72	0.89	Tr.	Tr.	Tr.	0.90
K_2O	1.30	0.34	2.20	0.55	1.92	0.76	1.86	0.92	0.30	0.25	1.45	0.54
Na_2O	0.04	0.37	0.35	0.11	0.76	0.42	0.38	0.60 (0.84 SO_3)	0.13	0.15	0.26 (1.69 SO_3)	0.18 (1.52 SO_3)
b.e.c.* ..	5.4	7.3	12.1	28.44	17.3	7.53		14.9	4.92	8.12	30.6	31.7
pH in water ..	5.7	5.9	7.62	4.74	5.2	5.82		5.85	5.7	7.38	4.82	5.9
Cone fusion point (deg. C.)	+1,750	+1,750	1,700	1,710	1,695	n.d.	1,620	1,700	1,580	1,550	1,690	1,740
D.T.A.†												
....*a*.. ..	www	www	s	s	w	fs	fs	fs	s	s	s	s
b ..	—	—	—	—	—	451 s	420 s	—	—	250 fs	350 sss	350 sss
c. ..	567 ss	562	534 s	520 s	521 s	539 s	538 s	542 ss	531 s	539 s	546 fs	542 s
d.. ..	992 ss	1,000 sss	975 w	962 s	965 w	966 fs	955 w	976 fs	950 ww	954 fs	941 ww	978 s

* Base exchange capacity by milli-quivs. per 100 gm. clay.
† Differential thermal analysis peak temperatures (deg. C.). s = strong peak; w = weak peak; fs = fairly strong, etc.

different sources have been examined. The bonding properties of 22 of these, which can be regarded as fairly typical, are summarized in Fig. 12, which shows the green- and dry-strengths of mixtures of Chelford sand with 5 per cent. clay addition at 2.5 and 4.5 per cent. moisture. The hatched horizontal lines show the corresponding values for Chelford sand with 5 per cent. Wyoming bentonite. The excellent properties of some of the bentonites from the Mediterranean area will be noticed. Table II shows the chemical and physical characteristics of these clays.

Bonding Properties of British Clays

The use of indigenous bonding-clays in whole or partial substitution for expensive imported

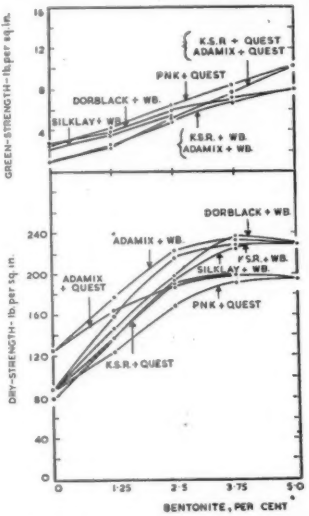

FIG. 14.—*Variations of green- and dry-compressive strengths with bond composition for Chelford sand bonded with mixtures of bentonite and various non-bentonitic clays: (Total clay content 5 per cent. moisture constant at 4 per cent.; AFS test-pieces, 10 rams.)*

bentonites has attractive possibilities for the British steel-foundry industry. During the last war, a treated native Fuller's Earth was in fact used in considerable quantities by the industry for this purpose and this material is still widely used by the cast-iron foundries where conditions are less severe than in steel casting. Native ball-clays and plastic fireclays were also used in appreciable quantities at that time and it was known to the Authors that a number of steel foundries were still using clays of this type mainly in the preparation of large dry sand and "compo" moulds where up to 20 per cent. addition of the clays might be made. Such large additions are possible because of the highly refractory nature of such clays and also because of their lower cost.

The question of interest to the Authors, however, was whether clays of the non-bentonite type could be used with advantage in ordinary green- and dry-sand practice involving castings of more moderate size. As shown by Davis and Rees[13] who tested a number of clays of this type during the war, the green- and dry-strengths obtainable with such clays are considerably less than those obtainable by the same addition (on a weight basis) of bentonite. Because of the favourable cost factor, however, it would be possible to use appreciably higher clay contents than when bentonite was used. Since no exhaustive survey of British clays had previously been made from this point of view, the bonding characteristics of a representative number of them have been examined. In all, 36 clays were examined including china-clays, ball-clays, fireclays

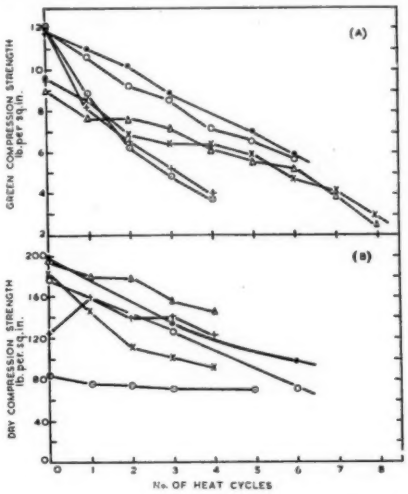

FIG. 15.—*"Life" test curves for various bentonites (A) green-strength; (B) dry-strength (4 per cent. moisture, 10 rams). Key: O Italian (9); • Italian (10); × Greek; ⊙ Canadian (18); + North African, and Δ Wyoming*

(both siliceous and aluminous) and highly siliceous clays of the type found round Kingscliffe in Northamptonshire.

The bonding tests showed that the aluminous, highly-refractory fireclays gave very low green- and dry-strengths and were unlikely, therefore, to be of use as bonds. Amongst the remaining clays it was found that many showed almost identical bonding characteristics with others of the same type. Twelve of the clays have, therefore, been selected to illustrate the typical properties obtained. Fig. 13 shows the green- and dry-compressive strengths obtained with 7.5 per cent. additions of these to the Chelford sand. The strengths obtained at 10 rams with 3.5 per cent. Wyoming bentonite and 2.5 per cent. and 4.5 per cent. moisture are also included in the diagram for comparison.

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The descriptions of the 12 clays, together with other relevant test data are shown in Table III. Two of them, Nos. 11 and 12, were found to contain a considerable content of organic matter as indicated by their high loss-on-ignition value. These had probably been added intentionally.

It will be seen that dry-strengths falling within the range obtainable with 3.5 per cent. Wyoming bentonite are only obtained at the higher moisture-content when the green-strengths are generally rather low. Hence higher clay-contents than the 7.5 per cent. addition actually used would be necessary to obtain the same combination of green- and dry-strengths as that given by the bentonite. On this basis, it appears unlikely that clays of this type could be used alone as bonds unless somewhat excessive additions were made.

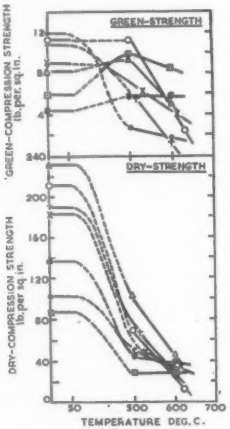


FIG. 16.—*Accelerated "life" tests on bentonites and kaolinitic clays; Chelford-sand mixes with 5 per cent. bentonites and 7.5 per cent. ball-clays respectively, (4 per cent. moisture: 10 rams). Key:* O *Italian* (10); • *Canadian* (18); + *North African;* Δ *Wyoming;* × *Greek;* ⊡ *Ball Clay* (5), *and* * *fireclay* (6).

Partial Substitution of Bentonite by British Clays

Since the possibility of finding native non-bentonite clays capable of replacing bentonite completely did not appear too promising, the bonding properties of mixtures of clays of this type with bentonites were investigated. The following combinations were selected for study:—

(*a*) Ball-clay No. 4 + Wyoming Bentonite.
(*b*) Plastic-fireclay No. 6 + Wyoming Bentonite
(*c*) Siliceous clay No. 9 + Wyoming Bentonite.
(*d*) Siliceous clay No. 10 + Wyoming Bentonite.
(*e*) Ball-clay No. 5 + Mediterranean Bentonite.
(*f*) Siliceous clay No. 9 + Mediterranean Bentonite.
(*g*) Siliceous clay No. 10 + Mediterranean Bentonite.

Fig. 14 shows how the green- and dry-strengths vary with the composition of the bond at 4 per cent. moisture. With all of the combinations investigated, a considerable replacement of the bentonite can be made (up to 50 per cent.), without loss of dry-strengths. The green-strength however, shows an approximately linear variation with bond composition. Between 40 per cent. and 50 per cent. replacement of the bentonite is necessary however, before the strength drops below that obtained with 4 per cent. bentonite alone at 4 per cent. moisture. These results appear to show that partial replacements of bentonite by selected native-clays holds distinct possibilities.

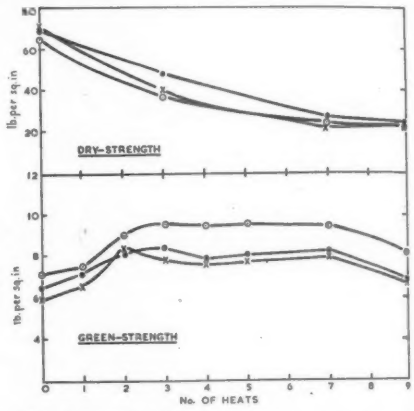


FIG. 17.—*Normal "life"-test curves of three ball-clays—Chelford sand bonded with a* 7.5 *per cent. ball-clay addition* (3.5 *per cent. moisture:* 10 *rams*).

"Life" of Bonding Clays

(*a*) *Bentonites*

Davison and White[12] investigated the effect of heating on the absorptive capacity, cation exchange capacity, green- and dry-strength, etc., of clays. On the basis of their work they proposed a laboratory test for assessing the "life" of bonding clays. The method used was to heat a block of clay-bonded sand from one end under standard conditions, after which the sand was milled at a defined water-content and tested for green- and dry-strength. The cycle was then repeated and graphs plotted of strength against the number of cycles. The rate at which the green-strength decreased was taken as giving a measure of the "life" since green-strength rather than dry-strength appeared to be the limiting factor. Fig. 15 shows "life" curves determined in this way for a number of typical bentonites.

Since the test was somewhat tedious to carry out, they suggested that "life" might be assessed equally well by preheating the clay to various temperatures and determining the change in green-strength obtained in standard sand mixes. Further work has confirmed this supposition, and has shown that clays can be differentiated by determining the green-strength after preheating for two hours at 500 and 600 deg., and comparing the strengths obtained with those prior to preheating. Fig. 16 shows the results obtained with five of the bentonites, the "life" curves of which are shown in Fig. 15. It will be seen that on the basis of green-strength, that the new accelerated-test places these in the same order as did the earlier test. For comparison, results for two kaolinitic clays are also included in Fig. 16. It will be seen that as shown by Davison & White an increase in green-strength occurs when the clays are pre-heated to moderate temperatures.

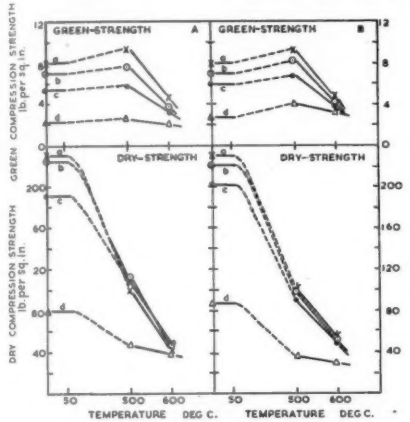


FIG. 18 (A).—*Accelerated "life"-test on (a) Wyoming bentonite and fireclay (6) (b) Wyoming bentonite and ball-clay (5), Chelford sand with 5.0 per cent. total clay addition (4 per cent. moisture; 10 rams).*

	(a)	(b)	(c)	(d)
Key: (A) Bentonite (per cent.)	5	3.75	2.5	0
Fireclay " "	0	1.25	2.5	5
(B) Bentonite " "	5	3.75	2.5	0
Ball clay " "	0	1.25	2.5	5

(b) Mixtures of Bentonitic and non-Bentonitic clays

Normal "life" curves of three non-bentonitic clays are shown in Fig. 17, which confirms that, on the basis of the laboratory test at least, long life might be obtainable with these clays. This was of particular importance from the point of view of the possible use of bentonites mixed with native, non-bentonitic clays, since such mixtures might prove to have superior life to bentonites alone

To test this possibility, mixtures of two bentonites with two native kaolinitic clays were tested using the accelerated "life" test. Chelford sand was again used, the total clay addition to the sand being 5 per cent. by weight in all cases, based on the weight of the clays prior to heating. (In practice it would be possible to increase the clay content above this figure when using the cheaper native clays, but it was considered desirable to keep the clay content constant in the laboratory work). The green- and dry-strengths obtained are shown in Figs. 18 (*a*) and (*b*,) and the curves clearly show that the mixtures retain their green-strength after heating better than do the bentonites alone.

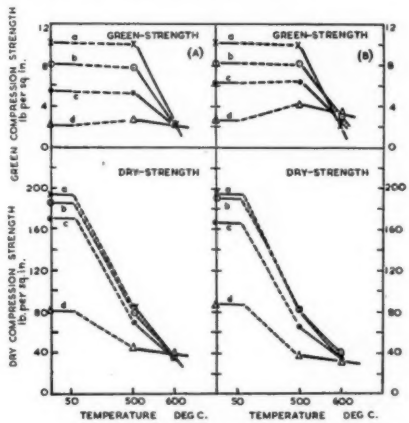


FIG. 18 (B).—*Accelerated "life"-test on (a) Italian bentonite and fireclay (6), (b) Italian bentonite and ball-clay (5), Chelford sand with 5.0 per cent. total clay addition (4 per cent. moisture, 10 rams).*

	(a)	(b)	(c)	(d)
Key: (A) Bentonite (per cent.)	5	3.75	2.5	0
Fireclay " "	0	1.25	2.5	5
(B) Bentonite " "	5	3.75	2.5	0
Ball clay " "	0	1.25	2.5	5

MOISTURE RESISTANCE OF DI-ELECTRICALLY-BAKED CORES

Organic core-bonds are generally tested by determining green-compressive strengths and dry-tensile strengths, after baking for various times at selected temperatures, to ascertain the optimum baking conditions. Where drying oils or synthetic resins are tested, strengths are also determined with various

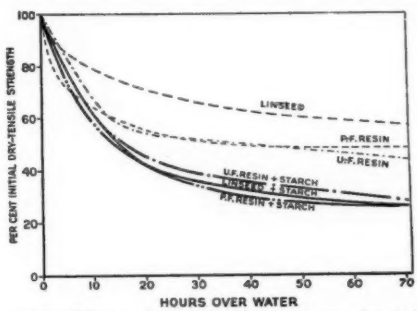


FIG. 19.—*Effect of starch additions on the fall-off in dry-tensile strength of linseed- and resin-bonded sand mixes when stored over water.*

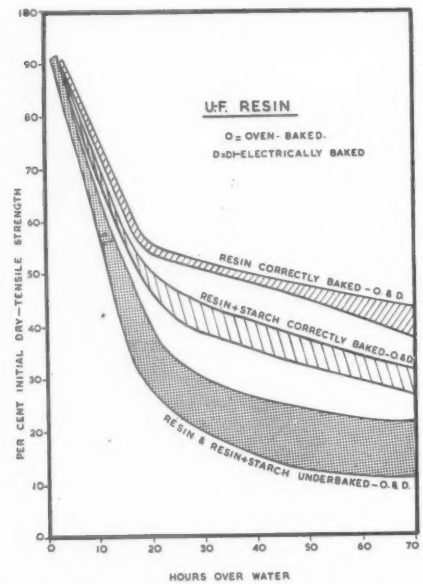

U-F. RESIN
O = OVEN-BAKED.
D = DI-ELECTRICALLY BAKED
RESIN CORRECTLY BAKED - O. & D.
RESIN + STARCH CORRECTLY BAKED - O. & D.
RESIN & RESIN + STARCH UNDERBAKED - O. & D.
PER CENT INITIAL DRY-TENSILE STRENGTH
HOURS OVER WATER

FIG. 20.—*Effect of under-baking on the moisture-resistance of u.-f. resin and u.-f. resin/starch bonded cores baked in an oven and di-electrically.*

For correct-baking data see Table IV; under-baking data as follow :—

	Oven	Di-electric
2 per cent. resin ..	170 deg. C., 15 min.	0.6 kw, 6 min.
1 ,, resin ..	170 deg. C., 15 min.	0.6 kw, 2½ min.
1 ,, starch ..		

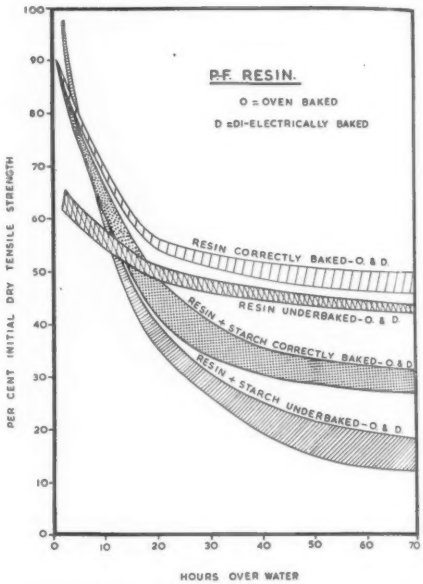

P-F. RESIN.
O = OVEN BAKED
D = DI-ELECTRICALLY BAKED
RESIN CORRECTLY BAKED - O. & D.
RESIN UNDERBAKED - O. & D.
RESIN + STARCH CORRECTLY BAKED - O. & D.
RESIN + STARCH UNDERBAKED - O. & D.
PER CENT INITIAL DRY TENSILE STRENGTH
HOURS OVER WATER

FIG. 21.—*Effect of under-baking on the moisture-resistance of p.-f. resin and p.-f. resin/starch bonded cores baked in the oven and di-electrically.*

For correct-baking data see Table IV; under-baking data as follow :—

	Oven	Di-electric
3 per cent. resin ..	200 deg. C., 15 min.	0.6 kw, 5 min.
1.5 ,, resin .. }	200 deg. C., 15 min.	0.6 kw, 4 min.
1.5 ,, starch .. }		

additions of cereal and moisture. Moisture resistance is also assessed when required, from the fall-off in the tensile strength with time when baked cores are allowed to stand over water. The latter aspect has recently achieved additional significance due to the use of di-electric baking of resin-bonded cores. Cores made by this method under production conditions have been found to have increased susceptibility to this form of deterioration.

TABLE IV.—*Details of Experimental Mixes (Chelford Sand Base).*

Bond addition (per cent.).	Baking temperature, deg. C.	Baking time, hr.	Dry-tensile strength,* lb. per sq. in.
2.0 linseed	200	2	+350
1.0 linseed, 1.0 starch, 2.0 water	200	2	275
3.0 P.-f. resin	200	2	173
1.5 P.-f. resin, 1.5 starch, 3.0 water	200	2	360
2.0 U.-f. resin	170	2	223
1.0 U.-f. resin, 1.0 starch, 2.0 water	170	2	240

* AFS test-pieces rammed three times.

Oven-baked Linseed Oil and Resin Mixes Compared

Mixes were made using Chelford sand with linseed oil and typical phenol (p.-f.) and urea-formaldehyde (u.-f.) resins. From these, AFS tensile test-pieces (rammed three times) were made and baked at optimum temperatures (200 deg. C. for phenol resin and 170 deg. C. for urea resin). These test-pieces were tested after storing over water at room temperature (approximately 20 deg. C.) for various times. The sand mixes investigated, their baking treatments and their original dry tensile strengths are shown in Table IV. Curves showing the deterioration in strength of sand mixes bonded with (*a*) 2 per cent. linseed oil, (*b*) 3 per cent. p.-f. resin and (*c*) 2 per cent. u.-f. resin are shown in Fig. 19. It will be noted that, in the absence of a starch addition, the fall-off in strength of the resin-bonded mixes was more rapid than in the case of test-pieces bonded with linseed oil, there being little to choose between the results obtained with the phenol and the urea resins.

The addition of starch to these mixes (see Table IV) resulted in a marked deterioration in strength with time over water, as compared with the mixes without starch; furthermore, it will be seen that, when combined with starch, linseed oil shows no superiority in resistance to moisture pick-up over

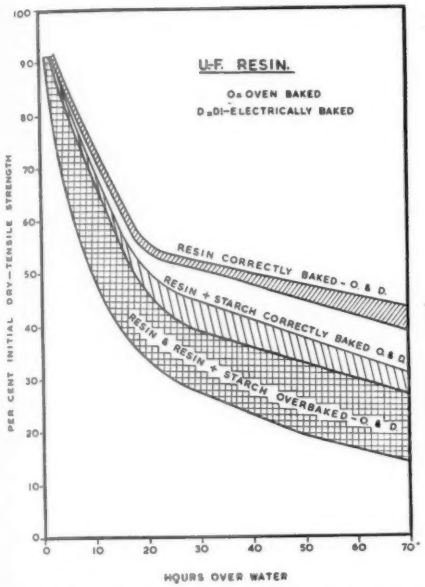

U-F. RESIN.
O= OVEN BAKED
D=DI-ELECTRICALLY BAKED
RESIN CORRECTLY BAKED - O. & D.
RESIN + STARCH CORRECTLY BAKED O. & D.
RESIN & RESIN + STARCH OVERBAKED - O. & D.
PER CENT INITIAL DRY-TENSILE STRENGTH
HOURS OVER WATER

FIG. 22.—*Effect of over-baking on the moisture-resistance of u.-f. resin and u.-f. resin/starch bonded cores baked in the oven and di-electrically.*

For correct-baking data see Table IV; oven-baking data as follow :—

	Oven	Di-electric
2 per cent. resin ..	200 deg. C., 2 hrs.	1 kw., 8 min.
1 ,, resin .. }	200 deg. C., 1 hr.	1 kw., 6 min.
1 ,, starch .. }		

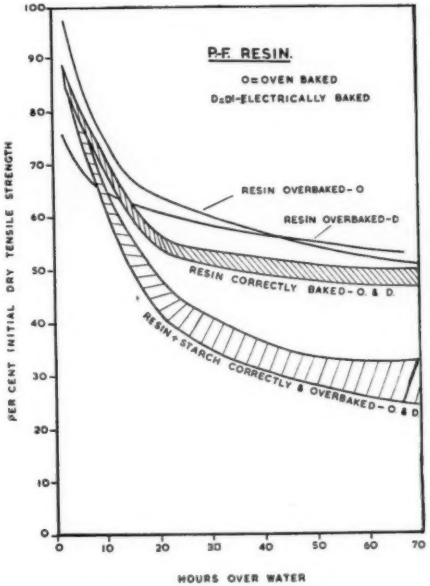

P-F RESIN.
O= OVEN BAKED
D=DI-ELECTRICALLY BAKED
RESIN OVERBAKED - O
RESIN OVERBAKED - D
RESIN CORRECTLY BAKED - O. & D.
RESIN + STARCH CORRECTLY & OVERBAKED - O & D
PER CENT INITIAL DRY TENSILE STRENGTH
HOURS OVER WATER

FIG. 23.—*Effect of over-baking on the moisture-resistance of p.-f. resin and p.-f. resin/starch bonded cores baked in the oven and di-electrically.*

For correct-baking data see Table IV; oven-baking data as follow :—

	Oven	Di-electric
3 per cent. resin ..	225 deg. C., 2 hrs.	1.0 kw., 10 min.
1.5 ,, resin .. }	220 deg. C., 2 hrs.	1.0 kw., 8 min.
1.5 ,, starch .. }		

the resin/starch mixes. These findings were confirmed by tests in which starch and dextrin alone were used as bonding agents.

Di-electric and Oven Baking Compared

Testing Procedure.

Tensile test-pieces were prepared using Chelford sand-bonded with typical phenol and urea-formaldehyde resins and with resin/starch mixtures. The test-pieces were baked di-electrically and in the oven for various times and temperatures and power settings to produce underbaked, correctly-baked and over-baked cores, as indicated by the appearance, hardness and baked-strengths obtained. Dry-tensile strengths were determined for some of the samples immediately they had cooled to room temperature. The remainder were tested after they had been stored for various times over water. The di-electric heater employed had a maximum output of 1.2 kw. at a frequency of approximately 20 megacycles, the power output being manually controllable from 0 to 1.2 kw. Correctly-baked cores being generally obtained after 6 min. at an output of 0.8 kw.

Effect of Under-baking.

It will be seen from Figs. 20 and 21 that the effect of under-baking both straight u.-f. and p.-f. resin and u.-f. and p.-f. resin-starch mixes is to lower the moisture resistance of cores baked di-electrically or in the oven.

Effect of Over-baking.

The effect on moisture resistance of over-baking u.-f. resin and u.-f. resin/starch mixes is similar to that of under-baking, irrespective of the baking method employed (Fig. 22). In contrast, Fig. 23 shows that over-baking of cores bonded with p.-f. resin in the oven improves their resistance to moisture. The same trend is apparent in the case of di-electrically over-baked cores, although their initial loss of strength is greater than that occurring in the case of correctly baked cores. The moisture

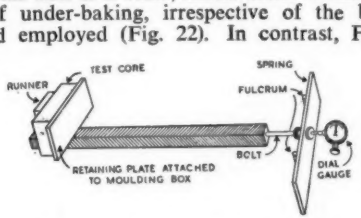


FIG. 24.—*Isometric sketch of the hot-tear apparatus.*

resistance of cores bonded with p.-f. resin and starch is similar in both the correctly baked and over-baked conditions.

It will be seen from the illustrations that in all cases the correctly baked resin/starch mixes showed less resistance to moisture than the straight resin-bonded cores, irrespective of the method of baking. The results also show that correctly baked resin/starch-bonded cores are as resistant to moisture pick-up as are the linseed/starch mixtures, but that under-baking causes a rapid deterioration in moisture resistance. Given correct conditions, the di-

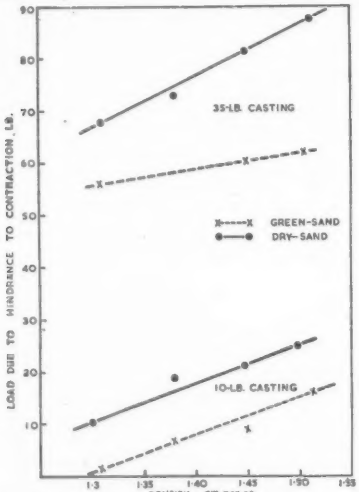


FIG. 25.—*Effect of "green" and dry density on the loads induced in the 10-lb. and 35-lb. castings, during the time of tearing.*

electric process is capable of efficiently baking resin and resin/starch mixes.

It must be remembered that the experiments have all been conducted upon AFS tensile test-pieces, on laboratory-scale equipment. The efficiency of di-electric baking is largely determined by the ability to maintain a constant air-gap between the top platen and the top of the core to be dried, and cores of uniform height and section such as have been employed are, therefore, ideally suited to this process. Some loss of efficiency must be expected when baking production-cores, even though care is taken to batch those of similar height and section thicknesses.

INFLUENCE OF MOULDING MATERIALS ON THE INCIDENCE OF HOT-TEARING

Cast steel has practically no strength and ductility at temperatures near to its solidus and if the resistance offered by the mould to the contraction of the casting at these temperatures is high the stresses induced in the casting may exceed the strength of the steel and rupture or hot-tearing of the casting will result.

Different moulding-media, by reasons of their chemical and physical compositions, have different strength properties at room and at elevated temperatures[14] and may therefore be expected to offer varying degrees of hindrance to the contraction of the casting whilst the steel is in the hot-tearing range, and thus affect the incidence of tearing. Recent work by one of the Authors[11, 15] has shown that the moulding material in contact with relatively small castings is rapidly heated to temperatures in excess of 1,400 deg. C. and that a depth of 0.15 in. of sand is quickly raised to temperatures above 1,250 deg. C. It was also shown that to

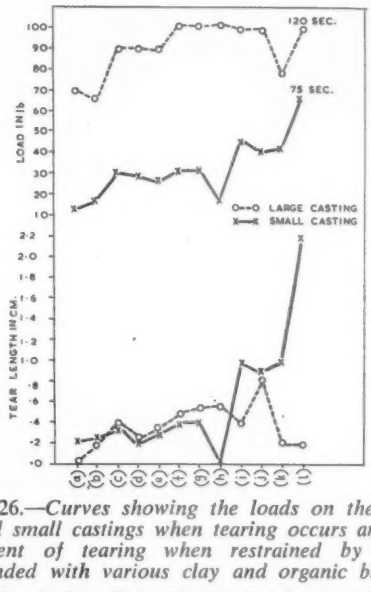


FIG. 26.—*Curves showing the loads on the large and small castings when tearing occurs and the extent of tearing when restrained by sands bonded with various clay and organic binders.*

Key: (a) Naturally-bonded sand; (b) 7.5 per cent. ball-clay; (c) 5 per cent. Mediterranean bentonite; (d) 3 per cent. bentonite (e) 5 per cent. bentonite; (f) 20 per cent. silica-flour plus 5 per cent. bentonite; (g) 7.5 per cent. fireclay; (h) 1 25 per cent. urea resin; (i) 1 25 per cent. phenol resin; (j) 4 per cent. semi-solid (k) 1.5 per cent. linseed oil, and (l) 2 per cent. linseed oil.

prevent tearing in these small castings the mould in the locality of the contracting members of the casting must be able to deform freely some 0.005 to 0.025 in. during the early stages (55 to 120 sec.) after pouring. The amount of deformation which a mould will undergo under these conditions without causing high stresses to be induced in the casting will be dependent upon the weakest component of that part of the sand mould which is between the members of the contracting casting. If the sand mix has low room-temperature strength-properties, but develops a high hot-strength, then it is the cooler positions of the mould which deform more easily; if the opposite is true and the mix has a high room-temperature strength and only a low hot-strength, then it is the hot layer of sand which is in contact with the contracting casting that deforms to the greatest extent. It is apparent from this that in

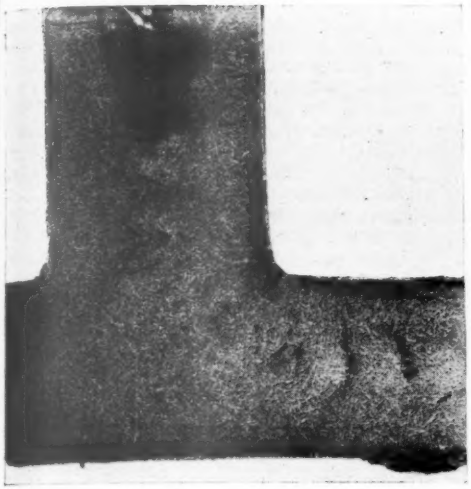
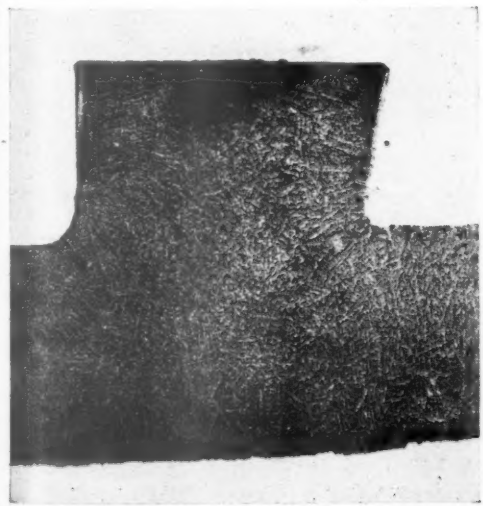


FIG. 27.—*Tear in the small casting restrained by dry-sand test-core bonded with* 5.0 *per cent. bentonite.*

order to keep the induced stress in a contracting casting at a minimum and so mitigate tearing, the moulding mix should have either a low room-temperature strength or develop a low hot-strength or what would be more effective, a combination of the two.

In the work referred to earlier[11,15] it was verified that certain moulding-media are capable of resisting the contraction of a casting to such an

FIG. 28.—*Tear in the large casting restrained by dry-sand test-core bonded with* 5.0 *per cent. bentonite.*



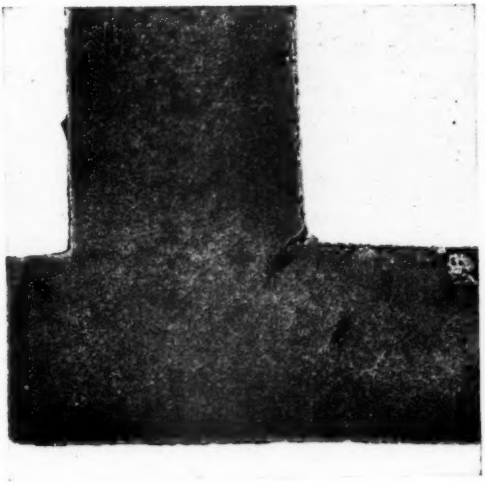
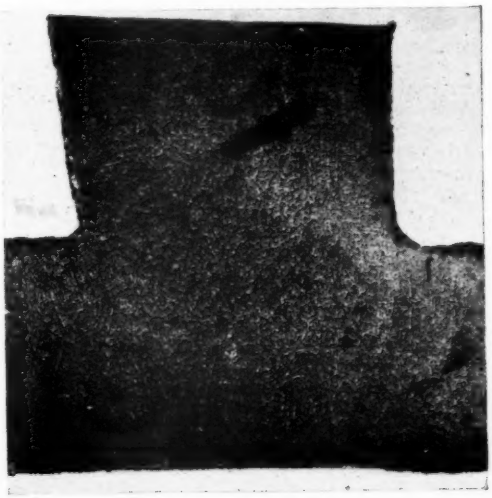


FIG. 29.—*Tear in the small casting restrained by dry-sand test-core bonded with* 1.5 *per cent. linseed oil.*

extent as to cause tearing of the metal and that variations in the moulding media such as ramming density and type of bond could affect the resistance to casting contraction and hence the incidence of tearing.

The type of apparatus used in this investigation is shown in Fig. 24. In this arrangement, the casting, test core and calibrated spring form a closed-stress system and the load induced in the casting by

FIG. 30.—*Tear in the large casting restrained by dry-sand test-core bonded with* 1.5 *per cent. linseed oil.*



the restriction offered to the movement of the casting by the test core is equal in magnitude to the load, causing deflection of the spring. By this means a comparison of the loads due to the hindrance to contraction offered by various moulding-media at any time after casting can be made. If the resistance to contraction is high, tearing occurs at the hottest, and consequently the weakest spot of the casting. In order to determine also the effect of variations in casting size two castings were used in the investigation, one of 10-lb. and the other of 35-lb. in weight.

Comparison of Green- and Dry-sands and the Effect on Ramming-density

Tests carried out on both castings hindered by bentonite bonded test cores in the "green" and dry state and rammed to various densities gave the results shown in Fig. 25. It will be seen that for identical densities, dry sands restrict the contraction of the casting more than "green" sands and so induce higher loads in the casting, and that the higher the green- or dry-density (and therefore the higher the compacts compressive strength) the greater is the load due to hindrance to contraction.* Examination of the castings for tears showed them to be present only in the small casting when it was restrained by the green- and dry-sand cores rammed to the highest density, and in the larger casting only when restrained by the higher-density dry-sand core. Whilst this investigation showed that as a general rule, and for a given sand mix, dry sands restricted the contraction of a casting more than "green" sands, there were occasions—as shown by the results obtained with the small casting—when it is possible for a green-sand which has been rammed to a high degree to resist the contraction of the casting more than a lightly-rammed dry-sand. In this case, it is probable that under casting conditions the high-density green-sand compact developed a higher hot-strength than did the lower-density dry-sand compact, and that a combination of moderate room-temperature-strength and high hot-strength, as associated with the green-sand, was more effective in hindering contraction than the combination of lower hot-strength and higher room-temperature-strength associated with the lightly-rammed dry-sand compact.

Comparison of the Effects of Various Bonds

A comparison of the loads induced in the two castings by the hindrance to contraction offered by sands bonded with various clay and organic binders is shown in Fig. 26, as are curves showing the extent of tearing associated with each bond.

(*a*) *Clay-bonded Sands.*

The two castings showed similar trends of load and extent of tearing with test cores bonded with clays. Slightly higher loads and larger tears were associated in both instances with castings restrained by cores bonded with fireclay and those to which silica-flour had been added. It has long been recognized that silica-flour additions to a sand mix increases its hot strength.

No correlation appeared between the behaviour of the various clay-bonded moulding mixes under steel casting conditions and their room-temperature strength-properties. Sand compacts having high room-temperature strengths, *e.g.*: Tow Law naturally-bonded sand (compressive strength 245 lb. per sq. in.) presented lower resistance to casting contraction than did compacts having moderate room-temperature strengths, *e.g.*, a 7.5 per cent. fireclay mix of compressive strength 44 lbs per sq. in.

(*b*) *Organically-bonded Sands.*

High restraint and extensive tearing was encountered with the smaller (10-lb.) casting when hindered by mixes containing organic binders, especially the linseed-oil and p.-f. resin mixes, and it was apparent from the results that this size of casting did not provide the thermal conditions necessary to cause rapid collapse of the organic binder whilst the steel was in the hot-tearing range. The larger (35-lb.) castings contracted at a slower rate and tore at a later time after pouring (120 to 160 sec., as against 55 to 75 sec.) than did the small casting. This allowed more *time* in which the organic binders could burn away before the steel reached the dangerous hot-tearing range, with the result that with this size of casting the majority of organic binders produced only small tears. Typical examples showing the extent of tearing in the two castings when restrained by various bonds are shown in Figs. 27, 28, 29 and 30.

It is evident from this brief survey that certain progress has been made in determining the influence that variations in moulding media have upon the incidence of hot-tearing. For example, it has been established that to mitigate tearing the mould should be able to deform easily and that this is an attribute of green-sand moulds and moulds which have been lightly rammed. It has also been shown that the behaviour of moulding materials under casting conditions is linked with the size of the casting, and that sand mixes which cause tearing in one particular size of casting need not cause such extensive tearing in similar design castings of greater size and weight. There is also evidence to show that the room-temperature strength-properties of a sand mix give no indication as to how it will behave under casting conditions and that sands having moderate room-temperature strengths may hinder the contraction of a casting to greater extent and promote larger tears in the casting than sands which have very high room-temperature strength-properties.

Acknowledgments

The Authors' thanks (from J. A. Reynolds and A. Preece) are due to Dr. Fisher, assistant professor of metallurgy at the Royal School of Mines, London, and to Dr. Samways, for permission to use

(*Continued on page 82 at the foot of col. 2*)

* The reason for selecting the loads on large casting at 120 sec. and the loads on the small casting at 75 sec. after pouring was that it had been found that tearing of the respective castings occurred at these times.

New Equipment

Transformers for Wood Gluing

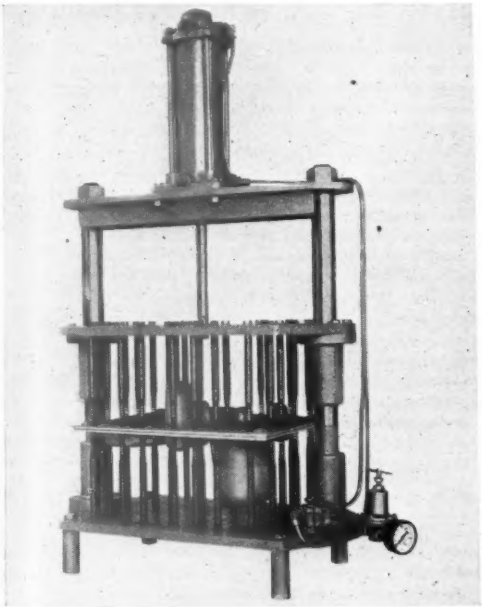
A low-voltage, high-current transformer, for use with strip or wire heating of synthetic adhesives, is being produced by Philips Electrical, Limited, Century House, Shaftesbury Avenue, London, W.C.2. Metal strips incorporated in the jig, or copper wires embedded in the glue layer, are frequently used in the cabinet and furniture trades for cutting setting times on small assemblies to a matter of minutes, and it is probable the system could also be applied to pattern-making.

Working from standard a.c. mains, of 200-250 v. this transformer gives outputs of 10 v. at 200 amps, 6 v. at 135 amps or 4½ v. at 90 amps—voltages low enough for the operator to do assembly work in complete safety whilst the current is on. At the same time, using 26-s.w.g. mild-steel strip as recommended, up to 20 ft. of strip 2-in. wide can be heated at 10 v. without overloading the transformer. The 4½-v. tapping is suitable for use with copper wire in the glue layer of assemblies difficult of access.

Closing of Shell Moulds

The Shalco Engineering Corporation, of 1,450, University Avenue, Palo Alto, California, announce the addition of a line of shell-mould closing-machines designed to deal with deep-drawn moulds. The sizes handled by the new machines range from 48 by 48 in. to 16 by 20 in. The machine, which is operated by compressed air utilizes pins and springs, appropriately placed, for fastening pasted, hot, half-moulds together by means of pressure. Fig. 1 shows the new machine.

FIG. 1.—*Shell-mould closing-machine made by the Shalco Engineering Corporation.*



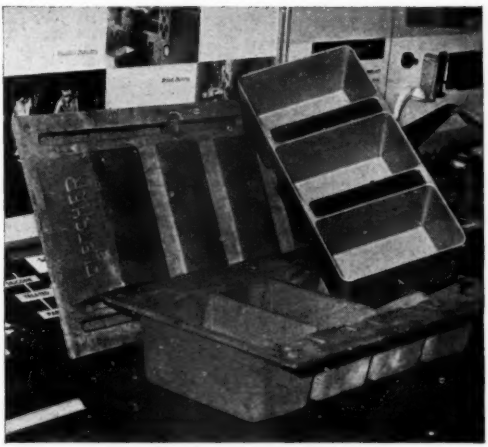


FIG. 2.—*Shell moulds and castings produced when using silicone release agents.*

Silicones in Shell Moulding

The use of silicones in shell moulding, it is claimed, enables the resin to fall away from the casting cleanly and without any difficulty. This was demonstrated at a recent exhibition of "Silicones in Industry" held in Manchester by Midland Silicones, Limited, 19, Upper Brook Street, London, W.1. Fig. 2 shows some of the results.

RICHARD CRITTALL & COMPANY, LIMITED, Great Portland Street, London, W.1, announce the addition of a new unit to their range of ventilation fittings. Known as the type "D" Deflecto grille, it is similar in design to the standard model, but length of throw, and zone of movement in the horizontal plane are controlled by individually adjustable rear blades, and directional movement in the vertical plane is controlled by front interlocked blades. Effective distribution of the air is obtained with both cooling and warming systems, as the front blades can be deflected upwards or downwards. The new grille is available in a wide range of sizes and may be supplied with or without the opposed blade damper. The latter unit embodies an equal number of damper blades for opposed movement and ensures that even air distribution and direction are maintained.

CHAMBERLAIN INDUSTRIES, LIMITED, of Staffa Works, Leyton, London, E.10, have recently completed a new design of tube-bending machine, manufactured under contract to clients' special requirements. The machine is capable of 180 deg. bends in tubes up to 3-in. nominal bore and radii in accordance with British Standards. The tubes are bent cold and unloaded, the actual bending time being 25 sec.

EFCO, LIMITED, announces the formation of a subsidiary company in South Africa, in collaboration with its South African agent, D. Drury & Company, Limited. The new company is named EFCO (South Africa) (Proprietary), Limited, and has an authorized capital of £S.A.50,000. The board will consist of J. A. Monks and J. C. Howard, who are also directors of EFCO, Limited, and, as South African members, A. D. Hodgson, R. P. Hacking and H. G. Goyns. The registered office is in Johannesburg. The company will supply all types of electric-furnace equipment for melting and heat-treatment of metals.

International Enamelling Congress

Preliminary Programme of October Meeting

To mark the 21st anniversary of its foundation the Council of the Institute of Vitreous Enamellers has announced that an International Congress on Vitreous Enamelling will be held in this country commencing on October 9 of this year. The first British International Congress on enamelling was held under the auspices of the Institute in 1948, when many wartime shortages and restrictions were still operating and the industry had not re-attained its peacetime status.

Since that time, there has been considerable progress, both in the design of plant and in the operation of the enamelling process, and those participating in the October Congress and its attendant works visits will be assured of much of interest.

Technical Papers

A very comprehensive programme of over 16 technical papers is planned as the technical centre-piece of this Congress. In addition, an account of the history of the Institute will be given by Mr. V. C. Faulkner, a founder member of the Institute and a past vice-president. While final titles and authors are in some instances still subject to confirmation, the sessions will include the following contributions emanating from this and many overseas countries as indicated:—

"Sheet-iron Vitreous Enamelling in Australia."
"Problems associated with Hydrogen Permeability"—Sweden.
"Enamelling of Holloware"—Germany.
"Quality Standards"—Netherlands.
"Viscosity of Enamels"—UK.
"Thermal Expansion of Enamels"—Netherlands.
"Enamelling in Building Construction"—USA.
"Development of Opacity in White Enamels"—USA.
"Enamelling Practice in Denmark."
"Heat-resisting Enamels"—UK.
"Practice in Colour Enamelling"—Yugoslavia.
"Developments in De-enamelling"—France.
"Aspects of Pickling"—UK.
"Fusion Welding for Subsequent Enamelling"—UK.
"Development of Screen-printing Processes in the Ceramic Industries"—UK.
"Fish-scaling Problems"—Germany.

The principal activities of this Congress will be centred on Leamington Spa where all the technical sessions will be held, as well as the main social function. However, in order to provide overseas delegates in particular, with the opportunity to study enamelling-works practice in this country, a comprehensive programme of works visits in various parts of the country is being organized to take place before and after the technical meetings.

Provisional Programme

Although final details have yet to be completed, the projected programme of the Congress takes the following form:—

Sunday, October 9.

Reception and dinner for overseas delegates by the president and Council on behalf of the Institute and industry at the Park Lane Hotel, London, W.1. The Park Lane Hotel will be the London headquarters of the Congress.

Monday, October 10.

Morning and afternoon will be taken up with visits to enamelling plants in the London area. In the evening, delegates will be received by the chairman and representatives of the Southern section of the Institute.

Tuesday, October 11.

Morning—depart for Leamington Spa visiting works in Oxford *en route*. Visits in the area will also be arranged for ladies. In the evening, there will be a reception by the chairman and representatives of the Midland section of the Institute.

Wednesday, October 12.

Morning and afternoon—technical sessions at the Town Hall, Leamington Spa; evening—Civic Reception by the Mayor and Corporation of the borough.

Thursday, October 13.

Morning—21st annual general meeting of the Institute, followed by technical sessions. Afternoon visits to enamelling works in the Midland area; evening—a visit to the Shakespeare Memorial Theatre, at Stratford-upon-Avon.

Friday, October 14.

Morning and afternoon—technical sessions at the Town Hall, Leamington Spa; evening—Congress banquet followed by dancing at Chesford Grange.

Saturday, October 15.

Morning—technical sessions at the Town Hall; afternoon—garden party by invitation at the home of the president of the Institute and Lady Briggs.

Sunday, October 16.

Travel from Leamington to Manchester by motor coach, luncheon *en route*.

Monday, October 17.

Morning and afternoon—visits to enamelling plants in the Manchester area; evening—reception by the chairman and representatives of the Northern section of the Institute.

Tuesday, October 18.

Depart from Manchester for a works visit in Bradford and then on to the Lake District where delegates will spend one night.

Wednesday, October 19.

Delegates travel to Edinburgh by motor coach.

Thursday, October 20.

Morning and afternoon—visits to enamelling plants in the Clyde/Forth area; evening—reception by the chairman and representatives of the Scottish section of the Institute.

Friday, October 21.

Morning and afternoon—further visits to enamelling plants in the area; evening—Congress farewell dinner.

Works Visits

The list of works to be visited in the various sections during the course of the Congress has yet to be settled, but already a number of invitations have been extended by companies with enamelling departments, including the following: Belling & Company, Limited, Benjamin Electric Company, Limited, Blake Vitreous Enamelling, Limited, R. & A. Main, Limited, Electrolux, Limited, English Electric Company, Limited, Pressed Steel Company, Limited, Parkinson Stove Company, Limited, Richmonds Gas Stove Company, Limited, Thomas De La Rue, & Company, Limited, Stoves, Limited, Smith & Wellstood, Limited, and Falkirk Iron Company, Limited.

Preliminary details of the Congress have already been widely circulated by the Institute, both in this country and overseas, and it is expected that a large number of delegates from abroad will participate in all, or most, of the programme. All who are interested in receiving the final detailed programme, to be issued later this month, which will provide them with the opportunity of registering for the Congress, should communicate with the secretary, the Institute of Vitreous Enamellers, Ripley, near Derby, England, to ensure that their name is included in any future mailings relating to the Congress.

International Metallurgy

Details of Continental Meetings and Tours

The itinerary of technical discussions, works visits and sight-seeing tours for British and overseas delegates to the joint metallurgical societies' meeting in Europe proved quite exhausting for those who faithfully followed it through from June 1 in London to June 18 in Paris.

Delegates from the American Institute of Mining and Metallurgical Engineers, American Society for Metals, Iron and Steel Institute, and Institute of Metals, as well as French, Belgian and Swiss visitors were welcomed at the Residenz Theater in Graf Adolfstrasse by Prof. Dr. H. R. Schenck, president of the Verein Deutscher Eisenhüttenleute and director of the Institute of Ferrous Metallurgy at the Technical University of Aachen, and Prof. Dr. P. Brenner, president of the Deutsche Gesellschaft für Metallkunde and professor at the Technische Hochschule in Hanover. They then gave, in turn, a review of the iron and steel industry, and the non-ferrous industry, in Germany, with information on current research work.

A feature of the opening session and subsequent technical sessions was the use of high-frequency radio to give simultaneous translations into English and French of the German speakers, and vice versa.

Technical discussions commenced on the afternoon of June 9, and subjects covered most aspects of practical metallurgy, including blast-furnace and coke-oven practice, steelmaking and continuous casting, rolling-mill problems, mechanical descaling, pickle waste, physical metallurgy, fuel economy and non-ferrous metal production.

Pre-refining of Iron

June 10 was devoted to works visits, one of these being to the firm of Hüttenwerke Oberhausen A.G. This works has been a pioneer in the use of oxygen in steel-making, and is carrying out both production and research with oxygen.

The company's research workers have devoted their energies to the development of two new pig-iron pre-refining processes over the past few years, on an extensive practical scale, using tonnage oxygen, which, they feel, has largely obviated the disadvantages of the older processes.

The first of the two new pre-refining processes has become well-known under the name of desiliconization. Oxygen is injected into the metal in the transport ladle by a water-cooled lance. A substantial proportion of Si and Mn is removed, with C and P remaining essentially untouched. The temperature of the iron is raised by 50-80 deg. C. This process was developed in the first place as an initial step in the basic-converter practice.

The basis of the second pre-refining method—the " rotor " process—is also the use of tonnage oxygen. Oxygen is employed in a vessel of special design and affords the possibility of a simultaneous combustion of carbon and phosphorus, besides a lowering of silicon. The process is applicable to practically all existing types of pig-iron The process can be controlled and reactions stopped at any desired carbon level. Experiments showed that carbon contents of 1-2 per cent. are most favourable for the subsequent processing of the iron in the open-hearth plant. During the development of this process on a production scale, successful work has been done to solve the problem of cleaning the waste gases at comparatively low cost in order to avoid smoke pollution of the atmosphere.

The rotary furnace, or " rotor," should not be confused with the type developed in Sweden by Kalling. The latter is used for desulphurization of pig-iron, with a reducing atmosphere and a lime slag, and rotates at about 30 r.p.m. The rotor at Oberhausen rotates at about 2 r.p.m., and a water-cooled lance injects oxygen to reduce the content of silicon, manganese, and carbon-plus-phosphorus, in that order, Some measure of desulphurization can be achieved if desired, but not so effectively as in Kalling's furnace.

The desiliconization of blast-furnace metal by oxygen lance was demonstrated, however, at a special station where the ladle, still on its bogie, is placed under a hood through which is inserted the lance to blow in 73 per cent. pure oxygen. This removes about 0.3 to 0.4 per cent. Si and 0.2 to 0.3 per cent. Mn, creating a temperature rise of 50 to 80 deg. C. The blow lasts from 30 to 40 min. The lance penetrates about 1 ft. under the metal surface, and about 8 cu. m. of oxygen per ton of metal are used. The ladles have a capacity of either 35 tons or 55-60 tons. There are six such stations, and all could operate at one time should the necessity arise.

Other works visited included Hüttenwerke Rheinhausen A.G., Deutsche Edelstahlwerke A.G., Mannesmann Hüttenwerke A.G., August Thyssenhütte A.G., Bochumer Verein A.G., Duisburger Kupferhütte A.G. and the Max Planck Institut.

Belgium and France

After an early start on Monday, June 13, the party travelled by special train to Liège, and were received by M. F. Perot, president of the *Centre National de Recherches Métallurgiques,* at a luncheon at " Le Mosan "—Jardin d'Acclimation. Four separate technical sessions and works visits were arranged for the afternoon: :—(1) Discussions on the sintering of iron ore from Luxembourg and Lorraine, followed by a visit to S. A. John Cockerill (belt charging of blast furnaces); (2) a meeting to discuss and visit the low-shaft furnace at Ougrée; (3) oxygen blowing of converters, with a visit to S. A. d' Ougrée-Marihaye, and (4) discussions on the resistance of low-alloy steels to creep at high temperatures, and the effect of vanadium, followed by a tour of the new CNRM laboratories.

Delegates arrived in Paris about 11.30 p.m. on

International Metallurgy

June 13. Welcoming speeches were made by M. R. de Vitry, president of the *Société Française de Métallurgie* and M. J. Sarrailh, Recteur de l'Université. Tribute was paid to the parts played by Mr. K. Headlam-Morley (secretary, ISI) and Dr. K. Thomas (director, VDE) in organizing the tour. Prof. P. G. Bastien then reviewed France's contribution to metallurgy.

Technical sessions and visits began in the afternoon of June 14. The former were held at the *Salle des Ingénieurs des Arts et Métiers*, in the Avenue d'Iéna. The seven possible visits covered a wide range of subjects, from motor-car manufacture to research in metallurgical chemistry. In the evening, all delegates enjoyed a reception given by the French Government.

Visits in France

The whole of the following day (June 15) was again devoted to technical discussions and works visits, one of which, to the Soc. Jacquet-Hispano-Suiza, brought out the great use which is being made of the technique of electropolishing in the production of gas turbines and gears.

Early in the morning of June 16 a short sightseeing tour of Metz, conducted by Prof. Roger Bour, had been arranged following which delegates visited the *Centre d' Etudes Supérieures de la Sidérurgie* (*CESSID*), where post-graduate metallurgical training for a limited number of students who have spent three or four years in industry is the main function of the establishment.

From CESSID, the party were transported by coach to Thionville where after seeing the modern flats erected for the staff, lunch was provided by the Société Lorraine de Laminage Continu (SOLLAC).

The afternoon was devoted to a visit to the SOLLAC works at Seremange where basic-Bessemer and open-hearth steel plants, coke ovens, a slabbing mill and a continuous, hot-strip mill were seen. Oxygen-enriched air is used in the Bessemer process. The Ebange plant is used for pickling and cold rolling. Returning to Metz in the early evening, all members attended an official reception and dinner arranged by the *Chambre Syndicale Sidérurgique de Moselle*. It should perhaps be explained at this point, that most of the works in this area of France operate on a co-operative system whereby, for instance, ingots produced at one works may be processed at another and so on.

On Friday, June 17, the party divided into two groups, one of which visited the coke-oven plant of the Charbonnages de France at Carling, and the coke-oven plant at Thionville.

The other group visited the works of the Union des Consommateurs de Produits Métallurgiques Industriels at Hagondange. In this works are six blast furnaces, five basic-Bessemer converters, open-hearth furnaces, cogging mill and various other rolling mills. The visit continued with an inspection of the works of Société des Aciers Fins de l'Est (SAFE) at Hagondange.

Returning to Paris on the evening of Friday, June

(*Continued at foot of column 2*)

17, all delegates went to IRSID at St. Germain-en-Laye on the following morning. The closing function of the tour, by invitation of the *Société Française de Métallurgie*, was an official reception and dinner in the Orangerie of the Palace of Versailles.

Mining and Metallurgical Congress

The *Société de l'Industrie Minérale* celebrated its centenary by a congress which was held last month, opening at St. Etienne and closing in Paris. The technical institution of French mining engineers and metallurgists, the *Société* arranged for more than 270 papers to be presented and discussed during the 15 days devoted to technical sessions. Covering a wide range of subjects, they were grouped under seven main headings—(1) mining of thick seams; (2) iron and steel manufacture and steel rolling; (3) mechanized getting and loading on longwall faces; (4) mechanized getting and loading in room-and-pillar workings; (5) mineral discovery; (6) underground electrification; (7) the mine of the future.

The discussion on the mining of thick seams took place at St. Etienne on June 16, 17, and 18 and thereafter the congress moved to Paris, where the other technical sessions were held in the conference rooms of the Centre Marcelin-Berthelot (Maison de la Chimie), in the rue Saint-Dominique. There was simultaneous translation of the papers and discussions in English, French, and German, reception being through small lapel-held short-wave receivers and headphones.

One of the highlights of the Paris meetings was the "Nuit de l'Industrie Minérale" in the Palais de Chaillot, which was graced with the presence of M. René Coty, President of the French Republic. There were ballet and a variety show, and dancing into the early hours of the morning.

Exhibitions

Throughout the conference an international exhibition was held in three sections. There was an exhibition of mining machinery and equipment on both banks of the Seine between the Invalides and l'Alma bridges. A number of foundry concerns were among the leading British mining machinery manufacturers which participated. The list included Anderson Boyes, British Jeffrey-Diamond, Climax Rock Drill & Engineering Works, Dowty, Holman Bros., Austin Hopkinson, Joy-Sullivan, Mavor & Coulson, Megator Pumps & Compressors, Mine Safety Appliances Company, Mining Engineering Company, Oldham & Son, and Ruston Bucyrus. Other British manufacturers were represented by their Continental agents.

An exhibition of mining models was held at the Maison de la Chimie and in the Place d'Iéne there were art exhibits drawn from mining and iron and steel producing countries in all parts of the world.

CO_2 Process Questions and Answers

When Mr. A. Talbot of Western Foundries gave his film and talk in connection with the CO_2 Process to London non-ferrous founders at a meeting of the Conditional Aid Service organized by the Association of Bronze & Brass Founders recently, he said that it is assumed that all members present understood what the CO_2 Process was, He explained that the film represented a job which was done in grey iron and pointed out that in the course of taking the film a slight mishap had occurred, all of which had been recorded. The film was then shown.

Mr. Talbot stated that the accuracy which could be obtained from this method was in every way comparable with the shell-moulding process and his company had expended only 2s. 8d. on their initial outlay of elementary equipment. Quite simple equipment could now be obtained for approximately £11. As guidance to members, he said that for 20 lb. pressure for a period of 20 seconds one should be able to treat a 10 in. cube of sand. So far as sand was concerned, for gunmetal he had used orthodox sand, either silica + Redhill H or dried Mansfield in the proportions of 75 per cent. silica and 25 per cent. of the finer sand.

Discussion

Mr. Talbot then answered the following questions:—

Question: Is plumbago mixed with a binder to give a skin suitable for the process?

Answer: The use of plumbago is considered to be a waste of money. Pelleted pitch gives as good a result and is much cheaper.

Question: What is the time required for mixing in a mill?

Answer: 100 lb. sand in 75/25 proportions using 4 per cent. binder and 1-2 per cent. pelleted pitch, mixed carefully, should require 3-4 min. For 88:10:2 gunmetal casting, Southport sand with Redhill H had given good results.

Question: Is any special kind of backing sand used with the black sand?

Answer: Ordinary backing sand is used. It could be left for a period up to six hours with no sign of moisture penetration. No trouble should be experienced if left for 3-4 hours.

Question: Is any special form of sand recovery recommended?

Answer: When oil-sand was used, recovery was not considered worthwhile, CO_2 sand practice follows the same principle.

Question: Does over-gassing cause any difficulties due to different thicknesses?

Answer: It is better to under-gas rather than over-gas.

Question: When using the process with aluminium-bronze, a clear strip down from oil sand has been obtained but with a layer of CO_2 sand adhering to the casting?

Answer: The speaker has had no practical experience with this to date, but with manganese-bronze a standard mix has proved very successful.

Question: How can trouble experienced when making a 6 ft. cylinder 7 in. dia. and gassing from both ends be cured?

Answer: It is better to insert a long CO_2 delivery pipe, withdrawing it steadily, having stopped up one end of the cylinder.

Question: Is painting of a spirit coating recommended?

Answer: When the cost of trimming is taken into account, spirit coating was found very economical, but do not use a spray to apply the coating.

Question: Why is there a freeze up in the valve coming out of a high-pressure bottle of CO_2?

Answer: The CO_2 should pass from the high-pressure bottle to a coil which is boxed and heated and then into two reducing valves. The first valve should reduce the gas from 750 to 250 lb. per sq. in. and the second should reduce it to the required 20 to 30 lb. per sq. in.

Question: When dealing with small cores, why is difficulty experienced in making both halves adhere together?

Answer: Try to keep them away from the air and use a binding solution. The air-drying fixative or gum is applied with a brush to one face only, it is not difficult to apply.

Question: Is there any danger in milling sand in lieu of mixing it.

Answer: No, an edge miller will give a better sand texture. Be careful that the machine is not suffering from wear.

Summing Up

In summing up, MR. W. R. BUXTON, the president, stated that he was most interested in the fact that the accuracy obtained from this process should be as good as shell moulding at one-eighth the price. It was also interesting that there were no noxious fumes attached to the process.

In proposing a vote of thanks, MR. WEBSTER said that it was a long time since so many learnt so much in so short a time and added that the lecture had been delivered in language which all founders understood. As practical foundrymen, all members were interested in the very satisfactory way in which "wasters" had been dealt with in the film.

The vote of thanks was carried with acclamation and the chairman said that the date of the next meeting had been fixed for September 25, when an endeavour would be made to obtain a lecturer to give a talk on foundry costing for small founders.

Personal

Sir ERNEST LEVER, chairman and chief executive of Richard Thomas & Baldwins, Limited, is to visit the company's Cookley works at Brierley Hill to-day to open a new training school and laboratories.

THE APPOINTMENTS of a new comptroller, Mr. J. O. SEWELL and a budget manager, Mr. B. A. SHORTMAN, for the Yale & Towne Manufacturing Company's lock and hardware division at Willenhall and the materials-handling division at Wednesfield, were announced on July 12.

Mr. CYRIL N. TAYLOR has been appointed director of Sheffield and District Engineering Trades Employers' Association. For 12 years he has been personnel manager at Rotol, Limited, manufacturers of aircraft equipment, which is a subsidiary of Rolls-Royce, Limited, and Bristol Aeroplane Company, Limited.

IN ANNOUNCING in the JOURNAL recently the appointment of Mr. J. B. Bucher as chief engineer of Davy & United Engineering Company, Limited, an error of tense was made. The note about his work on closed-cycle gas-turbines should have been in the past tense, as this referred to the period when he was chief engineer with John Brown & Company (Clydebank), Limited.

The Ministry of Supply announces the appointment of Dr. R. COCKBURN as Deputy Controller of Electronics in succession to Rear-Admiral G. Burghard, whose tour of duty has expired. Dr. Cockburn, who is 44, has been Principal Director of Scientific Research, Guided Weapons and Electronics, since March 1, 1954. Before that he was scientific adviser to the Air Ministry.

Dr. E. J. WARLOW-DAVIES has been appointed deputy chief engineer of the engine division of the Bristol Aeroplane Company, Limited, and a member of the divisional board. Mr. S. S. TRESILIAN becomes an assistant chief engineer and Mr. B. S. MASSEY an assistant chief designer. Mr. B. D. BLACKWELL has been made engineer in charge of a new department for the development of turbine blades.

Mr. H. R. BURKINSHAW is joining the London staff of Edgar Allen & Company, Limited, in November. He joined the foundry department in 1917, but in 1922 went to the company's Calcutta agents, Jessop & Company, Limited, where he eventually took charge of the metals and stores department. In 1946 he was appointed Jessop's managing director, retiring from the position this year.

Mr. A. W. HANSON, until recently manager of the Karachi office of Babcock and Wilcox, Limited, has been appointed by the company to the managership of their Newcastle office. Mr. P. R. BETTLE is his deputy. Mr. Hanson, who has wide experience in marine engineering, was formerly chief inspector of boilers to the Burma Government, and joined the service department of Babcock & Wilcox, Limited, in 1946; he opened up the Karachi office in 1949.

Councillor E. N. HILEY, secretary of the National Brass Founders' Association, has presented to Warwick County Museum two brass idols and is to present a similar pair to the Birmingham Museum of Science and Industry. The idols are of the type which were made by Birmingham brassfounders at the beginning of the nineteenth century, and shipped to West Africa in large quantities; the trade died out in the middle of the last century.

SEVEN MEN who have just concluded their service with Newton Chambers & Company, Limited, Thorncliffe Works, Chapeltown, Sheffield, have a combined total of 374 years' work with the firm. Seventy-nine-year-old FRED BAILEY, of the joiners' shop, has been with the company for 68 years and during that time has been late only twice. He started at 10 years of age as a pony driver at Smithy Wood Colliery. JOHN WILLIAM STEEL, (70), has 57 years' service with the firm.

Mr. H. H. HATTON has been appointed assistant manager of the Liverpool branch of the General Electric Company, Limited. Mr. Hatton was educated at King Edward VI School, Stratford-on-Avon, and joined the GEC in 1933 as a student apprentice at the company's Witton engineering works. Subsequently, he was appointed to the engineering estimating department and export sales department at Witton. In 1939, he joined Manchester branch, engineering department; in 1946 was appointed to the industrial sales department, and in 1950, became manager of that department at Liverpool.

Obituary

Mr. DICK BILLBROUGH, a former chief draughtsman at Herbert Morris, Limited, of Loughborough, until his retirement eight years ago, has died in Loughborough hospital, at the age of 73.

Mr. LEONARD PYWELL, London director of Gent & Company, Limited, electrical and horological engineers, of Leicester, since 1946, has died at the age of 56. He joined the company at Leicester in 1915 and had been in charge of the London office since 1925.

Mr. FREDERICK STONES, secretary of Samuel Fox & Company, Limited, steel manufacturers, Stocksbridge, Sheffield, died on July 13 after a nine-month illness. He was 49, and had been with the firm for 29 years. Part of this time was at the Scunthorpe and Workington branches.

Mr. GILBERT W. GOLDING, who was formerly secretary for 20 years of the Metal Agencies Company, Limited, Bristol, has died at the age of 67. He joined the company in 1905 and for two years before his retirement in 1953 he was a director of the subsidiary, Cotterell Bros.

Mr. J. MCNAIR, foundry superintendent at Phosphor Bronze Company, Limited, where he was in charge of all the foundries, died recently, aged 49. He was well-known in non-ferrous metal foundry circles in both England and Scotland. Mr. McNair joined the company in 1939.

The death has occurred of Mr. EDWIN DEMPSTER, who was secretary of the Northern Ireland Association of the Engineering and Allied Employers' National Federation from 1921 to 1953. Previously he had been secretary of the Iron Founders and Brass Founders' Association of Ireland.

Mr. JOSEPH FREDERICK RUTTER, of Stourbridge, has died at the age of 65. About 31 years ago he and his brother founded the business of Rutter Brothers, engineers and ironfounders in Brettell Lane, Amblecote, Stourbridge. For some years, he was an instructor on foundry practice at Brierley Hill Technical Institute evening classes.

The death has occurred of Mr. HENRY GRINDALL, a director of Wagon Repairs, Limited. His resignation as a special director and joint secretary of the Metropolitan-Cammell Carriage & Wagon Company, Limited, and Metropolitan-Cammell-Weyman Motor Bodies, Limited, on reaching retirement age was announced in January, 1953.

Imports and Exports of Iron and Steel in May

The following tables, based on Board of Trade returns, gives figures of imports and exports of iron and steel in May. Totals for the first five months of this year and last are also included.

Total Exports of Iron and Steel

Destination.	Month ended May 31.	Five months ended May 31.	
	1955.	1954.	1955.
	Tons.	Tons.	Tons.
Channel Islands	509	1,821	2,841
Cyprus	588	3,025	2,242
Sierra Leone	1,315	5,456	4,352
Gold Coast	2,167	15,591	11,671
Nigeria	4,573	22,696	19,831
Union of South Africa	4,954	16,634	35,324
Rhodesia and Nyasaland	6,389	25,612	31,205
Tanganyika	2,074	5,859	6,892
Kenya	6,680	29,793	25,239
Uganda	380	3,013	1,943
Mauritius	288	3,198	1,127
Bahrain, Qatar, and Trucial Oman	1,010	10,859	5,984
Kuwait	284	3,463	1,702
India	9,732	37,565	57,892
Pakistan	2,529	19,640	21,648
Singapore	2,782	12,714	16,896
Malaya	1,557	10,492	8,603
Ceylon	1,301	8,165	8,226
British North Borneo	307	1,652	1,902
Hongkong	4,069	7,702	21,131
Australia	29,157	92,316	102,688
New Zealand	23,973	75,121	121,711
Canada	14,260	78,248	43,316
Jamaica	1,032	6,053	5,429
Trinidad	5,329	16,992	23,369
British Guiana	603	2,135	2,943
Anglo-Egyptian Sudan	3,141	13,835	9,138
Other Commonwealth countries	2,563	9,993	15,138
Eire	4,467	20,374	23,828
Finland	6,855	25,775	32,488
Sweden	11,568	32,132	59,416
Norway	13,687	32,813	57,868
Denmark	8,980	39,753	37,179
Western Germany	440	2,328	2,745
Netherlands	8,409	40,701	44,292
Belgium	2,177	4,648	9,727
France	395	2,241	2,557
Switzerland	1,046	4,572	6,711
Portugal	1,518	4,693	5,889
Spain	9,483	1,756	32,017
Italy	3,556	21,967	12,826
Austria	322	476	1,298
Yugoslavia	935	2,323	9,229
Turkey	955	5,203	4,413
Netherlands Antilles	1,185	1,921	5,861
Portuguese E. Africa	137	1,177	711
Lebanon	2,074	763	2,801
Israel	930	4,200	4,607
Egypt	2,158	15,498	13,514
Saudi Arabia	661	1,165	4,190
Iraq	13,833	14,934	22,793
Iran	8,269	2,559	25,445
Burma	1,319	4,638	6,585
Thailand	506	3,089	2,378
Indonesia	338	3,117	1,573
Philippine Republic	884	1,698	2,689
USA	4,362	10,845	19,080
Colombia	415	2,512	3,355
Venezuela	3,290	16,429	26,223
Ecuador	403	1,312	1,256
Peru	1,534	2,812	4,702
Chile	103	693	571
Uruguay	124	7,774	3,418
Argentina	4,393	29,665	28,301
Other foreign countries	4,016	35,944	23,003
TOTAL	259,233	944,143	1,245,922

THE "*Iron Age*" for June 16, carries an article on shell cores, wherein it is stated that they can be blown at the rate of 240 per hour. The standard equipment occupies only 24 sq. ft. Much lighter in weight they are said to have excellent venting and collapsibility characteristics.

Total Imports of Iron and Steel

From	Month ended May 31.	Five months ended May 31.	
	1955.	1954.	1955.
	Tons.	Tons.	Tons.
Australia	36	9,488	43
Canada	15,994	3,081	44,897
Other Commonwealth countries and Eire	1,811	2,844	6,227
Soviet Union	18,100	85,347	88,877
Sweden	2,293	12,951	12,508
Norway	6,767	11,498	30 810
Western Germany	2,328	39.664	10,800
Netherlands	15,338	43,405	53,279
Belgium	10,796	20,196	43,718
Luxembourg	3,308	8,801	12,934
France	16,315	31,197	72,328
Italy	121	2,689	174
Austria	16,927	98,320	60,487
Japan	2.019	45	3,276
USA	72,638	37,665	283,836
Other foreign countries	530	153	5,165
TOTAL	185,321	407,344	729,359
Iron and steel scrap and waste, fit only for the recovery of metal	107,383	342,355	485,620

Exports of Iron and Steel, by Products

Product.	Month ended May 31.	Five months ended May 31.	
	1955.	1954.	1955.
	Tons.	Tons.	Tons.
Pig-iron	4,599	5,819	24,742
Ferro-columbium (niobium)*	5	—	44
Ferro-tungsten	48	307	213
Other ferro-alloys†	231	4,672	1,177
Ingots, blooms, billets, slabs, sheet and tinplate bars	239	1,258	2,972
Iron bars, rods, angles, shapes, and sections	374	1,117	1.804
Steel bars, rods, angles, sections, and shapes	40,938	123,504	197,786
Iron plates and sheets	26	324	75
Universal plates	576	2,547	4,311
Steel plates, ¼ in. and under ⅜ in.	2,115	5.200	9.701
Do. ⅜ in. and over	27,421	60,368	128.462
Black sheets and black plate	17,003	83.911	100.186
Hoop and strip	9,192	43,975	50,018
Tinplate	22,400	127,084	138.851
Tinned sheets, terneplate, and ternesheets	125	1,011	1,193
Decorated tinplate	591	1,078	1 641
Galvanized sheets	15,429	65.778	74.121
Other coated plates and sheets	1,038	3,702	5,844
Railway and tramway construction material	36,755	101,517	125.837
Wire rods	2,369	13.526	14,233
Wire	8,561	33,530	47,355
Tubes, pipes, and fittings	67,178	255,027	308,234
Iron castings	1,394	5,630	4,628
Steel castings	278	1,533	956
Forgings	348	1,725	1,538
TOTAL	259,233	944,143	1,245,922

* Not separately distinguished before 1955.
† The figures for 1955 are not completely comparable with those for previous years.

THE THIRD RESIDENTIAL COURSE for managers and assistant managers on management techniques and problems is to be held at Pendley Manor, Tring, commencing September 23. It is being organized by the Institute of Industrial Administration, and details are available from the secretary, Mr. W. C. Robinson, Davis Gas Stove Company, Limited, Bedford.

Book Reviews

Liechtmetall-und Schwermetall-Kokillenguss. (Chill-casting in Light and Other Metals) by Ernst Brunhuber, published by Fachverlag Schiele & Schön, Boppstrasse 10, Berlin S.W.29; price DM16.

The Author's purpose in this book is indicated first in the preface as an attempt to survey the fundamentals of the subject, as far as research in this field has provided useful results; and second, in the chapter headings, which cover the purpose of chill-casting, theory, methods (chill-cast ingots or plates, continuous casting, aluminium-alloy and copper-alloy shapes, and special processes), mould materials, layout of a foundry, and economics.

Among 39 literature references and 63 Patent specifications, only 10 items are non-German. The chapter on theory (pp. 11-29) covers viscosity of melts, surface tension, thermal conductivity and similarity considerations. No mention is made of the effects of gases in metals, a subject with which investigators and technologists in this field all over the world have been preoccupied for at least 30 years. Indeed, the only indications of gases in the index are the word "Entlufting" (occurring in three places in the chapter on casting processes in which passing mention is made of the design of moulds to permit escape of air) and one reference to the use of ultrasonics for degasification. The book is mainly devoted to the gravity-die-casting of shapes (56 pages, based on German Patent specifications up to 30 years old). By comparison, the casting of ingots for working receives ten pages, and continuous casting six pages. Pressure-die-casting is not mentioned.

To whom is such a book directed? A German foundryman might seek in it details of patented methods for casting certain objects (24 are listed in the index, including various types of valves). As a guide to modern knowledge of chill-casting it is quite inadequate.

B. F.

Cost Accounting and the Engineer, by Kenneth B. Mitchell, A.C.W.A., Aff.I.W.M., published for "Machine Shop Magazine," by Iliffe & Sons Limited. Price 10s. 9d. post free.

One of the great difficulties arising out of the way in which management is "trained" in Britain, is that a technician or an executive may not be required to know anything about cost accounting until he reaches the age of 40 or so. Then he finds himself promoted to a position which he cannot fill efficiently unless he has a grasp of the fundamental ideas behind this complex subject. Mr. Mitchell has attempted to give engineers the essential background in a book of just over 100 pages, written in a clear and simple style for those who have no previous knowledge of accountancy. He takes the reader step by step through the principles which form the basis of every costing and budgetary-control system in every type of factory, explains why each costing operation is necessary, and relates these principles directly to each practical consideration as whether or not to order new plant, wastage of material, economy of expenses, etc. One of the best features of the book is the emphasis on the practical application of costing; all costing is a waste of time and money unless the management acts on the information supplied. This little book will show executives and senior technical men how costing and budgeting can help them to produce maximum efficiency, and so prepare industry against future difficulties.

G. B. J.

New Catalogues

Steel Castings. John Fowler & Company (Leeds) Limited, Sprotborough, Doncaster, are to be congratulated on their new catalogue (publication No. 2875), because such good use has been made of contrast. On several pages are shown in the palest of blue an imposing machine, and then superimposed on this page and the one facing, are very clearly shown the castings which are incorporated in the plant illustrated. Throughout excellent balance has been maintained and yellow has not been used except for background and decoration; used in any other way it is difficult for many people to read. The text has been well written and is devoid of plugging which is the worst form of publicity. On the technical side there is a table giving specifications and applications. The views reproduced are clear and adequate, but the reader will miss a general view of the foundry. Yet the firm's publicity department was right as normally but little extra enlightenment is disclosed by their inclusion. The last two pages show iron castings, but not much information is given except as to specification number. The brochure would gain rather than lose by their omission.

Silica Bricks. General Refractories Limited, Genefax House, Sheffield, 10, have just issued a most interesting brochure covering a flint-based silica brick known as Densyl. Few booklets of this type have been so well written and immediately the interest of the reader is gained and maintained. The search for higher quality, the import from overseas sources of raw material and the final selection of cretaceous flint form the opening chapters. Then follows a detailed well-illustrated description of the plant installed for the manufacture of these new bricks. In the last section, the properties of Densyl bricks are tabulated. Finally, just a small criticism. On the cover, the word is written DenSyl, but thereafter as Densyl. This may have some importance in the field of trade marks. This very well produced catalogue is available to readers on writing to Genefax House.

Engineers' Pattern Shop Equipment. It is indeed a pleasure to receive a catalogue from the JOURNAL'S oldest advertiser—J. W. & C. J. Phillips, Limited, Pomeroy Street, New Cross, London, S.E.14. The firm took space in the very first issue in 1902 when it was ten years old. It is a very pleasing catalogue, carrying a brick-red stiff back, which when accommodated on a book shelf will always stand out. The firm is well known for its pattern letters and figures, and it takes about half-a-dozen pages to illustrate and list the varieties made. Dowels form another important section. A gadget which was new to the writer is a container carrying spirit in which to keep brushes in proper condition. Though old-established, the firm makes every effort to keep abreast with foundry developments and to supply the new demands. Interested readers should write to Pomeroy Street for this catalogue.

Furnaces and Charging Machines. A leaflet received from Gibbons Brothers, Limited, Dibdale, Dudley, carries a number of interesting captioned pictures of a wide range of furnaces and charging machines set out as a double-page spread. On the back page is listed the plant they manufacture for many branches of industry, including the foundry. Copies of the leaflet are obtainable on application to Dudley.

News in Brief

ALLIED IRONFOUNDERS, LIMITED, have had plans passed for the erection of buildings, including a garage, at Callendars Iron Works, Falkirk.

BRITISH ENGINES, LIMITED, has had plans approved for the erection of new foundry extensions at St. Lawrence Road, Newcastle-upon-Tyne.

AN AUTHOR of more than 70 books, Mr. Bernard Newman, has been employed by Ruston and Hornsby, Limited, Lincoln, to write a history of the firm.

THE BOARD OF TRADE have been advised that imported wire goods should bear an indication of origin at the time of importation and when offered for sale.

AUTO-METRIC PUMPS, LIMITED, has submitted plans for the erection of a new foundry workshop and stores building at West Kent Wharf, Maidstone, Kent.

PRESSURECAST PATTERN PLATE COMPANY, LIMITED, Lime Bank Street, Manchester 12, has, from June 1, changed its name to J. J. Harvey & Pressurecast, Limited.

HALL & PICKLES, LIMITED, of Manchester, are opening a new 20,000 sq. ft. factory at Kipling Avenue, Etobicoke Township, Canada, to manufacture metal tags and labels.

ARTHUR BALFOUR & COMPANY, LIMITED, Capital Steel Works, Sheffield, held their sports club's children's fete on Saturday, July 9. The prizes were presented by Mrs. Wright, wife of Mr. L. Wright, a director.

THE FOLLOWING APPOINTMENTS to the board of Martonair Limited, Parkshot, Richmond, Surrey, are confirmed: joint managing directors: C. D. P. Smallpeice (chairman), G. Godwin; director and secretary: R. C. Cartwright; and technical director: C. Kirk.

A NUMBER of additions are announced to the range of Allied Ironfounders' domestic fires—the Lexham, the Lowburn and the Marvec models—several versions of which are available with enamelled cast-iron decorative surrounds and/or heating boilers at the rear.

THE WORKS OF John Holroyd & Company, Limited, Rochdale, Lancs, will be closed from 5 p.m. on August 12 until 8 a.m. on August 29 for annual holidays. During this period goods cannot be received, but a skeleton staff will be in attendance to deal with urgent correspondence.

THE passenger cargo vessel Esperance Bay, of 14,343 gross tons, has arrived at Faslane on the Gareloch to be broken up by Shipbreaking Industries, Limited. The ship was built in 1922 and while on service flew the flag of the Aberdeen & Commonwealth Company—a subsidiary of the Shaw Saville Line.

THE Sloan royal flush valve, a sanitary appliance of interest to water and sanitary engineers, is being shown by Rowe Bros. & Company, Limited, builders' merchants, at the International Water Supply Congress and Exhibition, at the New Horticultural Hall, Westminster, London, from July 18 to 21.

E. W. WYNN (IRONFOUNDERS), LIMITED, Bridgtown, Cannock, anounce that their works closed for summer holidays from Friday evening July 22, and will re-open on Monday morning August 8. During that time no goods will be received or despatched, except by previous arrangement, but a small staff will be on duty to deal with urgent matters.

THE FORMATION of Johnsons Rolls, Limited, Hall End Iron Works, West Bromwich, from the foundry division of Johnsons Iron & Steel Company, Limited, has been announced, effective from July 1. Its interests are confined solely to the production of rolls and allied castings. Mr. F. W. R. Banks is chairman of the new company, and Mr. C. Rowley and Mr. K. H. Wright are directors.

THE BRITISH TRANSPORT COMMISSION announce that contracts have been placed with the following firms for 319 twenty-ton ballast and sleeper wagons as follow: Derbyshire Carriage & Wagon Company, Limited, Chesterfield, 100; Cambrian Wagon & Engineering Company, Limited, Cardiff, 169; and Gloucester Railway Carriage & Wagon Company, Limited, 50 wagons.

MR. J. R. A. BULL, managing director of Sanderson Brothers & Newbould, Limited, steel tools, Newhall Road, Sheffield, opened a new six-acre sports ground for employees at Hill Top, Kimberworth, Rotherham, on July 9. This is the third ground the firm has provided in the past 35 years; the first two were taken for housing. Prizes after a sports meeting were presented by Mrs. J. R. A. Bull.

BUYING AHEAD of the bulk of the spun-iron pipes for the £300,000 Barrow water scheme of North Lindsey Water Board has meant a considerable saving for the board. At their meeting on July 13 they were told by Mr. Cyril Cooper, the engineer, that two thirds of the pipes originally estimated to cost £112,000 altogether, had been delivered before the scheme started. The price of pipes has since increased and the remaining one-third will cost another £700.

A NEW heavy-duty fork-lift truck which can also serve as a rough-country multi-functional tractor is now undergoing proving trials in this country. Designed and produced by Conveyancer Fork Lift Trucks, Limited, Warrington, the machine is named the "Overlander" and is powered by a Leyland 350 cub. in. diesel engine. The Leyland Pneumo-Cyclic gearbox has been incorporated in its construction to provide the smooth and easy control essential in this type of work.

THE ANNUAL SPORTS DAY of Stanton New Works foundry on the ground at Hallam Fields was opened by Mr. L. Hearshaw (foundries superintendent). Among those present were Sir Frederick Scopes, managing director, accompanied by Lady Scopes; Mr. A. Watson, assistant managing director; Mr. Vernon Scopes, estates and brickworks manager; and Mrs. Scopes; Mr. J. E. A. King, personnel manager, and Mrs. King; Mr. S. Whitfield, manager of Riddings foundry, and Mr. F. Munrow, New Works foundry manager and Mrs. Munrow.

FOLLOWING THE ANNOUNCEMENT by Sir Edward Boyle, in the Budget debate on April 25, of the Goverment's intention to ask a number of firms to provide information about their capital expenditure, the Board of Trade is now writing to 650 companies asking them to co-operate in an inquiry designed to show quarterly trends in industry's capital expenditure and expected expenditure during the calendar year ahead. The information will materially help Government and industry to assess the extent of changes in the demand for capital assets both in the recent past and in the future.

THE STEEL WORKS of Steel, Peech & Tozer, Limited, Rotherham, may have television installed for industrial purposes. This was among the modern trends mentioned by Mr. Andrew Jollie, general manager, when he addressed technical journalists on July 12. Its use in steel works would enable operatives to observe processes photographed by the television cameras and projected on screens some distance away, and thus relieve workers in hot and uncomfortable conditions. It is thought that Steel, Peech & Tozer would be the first steel firm in the country to bring I.T.V. into use.

News in Brief

NEWTON CHAMBERS & COMPANY, LIMITED, Thorncliffe Works, Chapel Town, Sheffield, distributed nearly £400 on July 11, to 160 apprentices and office girls of the firm for their work at technical colleges and evening schools last winter. Sir Harold West, managing director, presided at the gathering, and Mr. M. L. Clement-Jones gave a report on the progress of the company's training scheme. The boys received a bonus from the Master Cutler, Mr. W. G. Ibberson, and the girls from the chairman of the West Riding Education Committee, County Alderman J. Fuller Smith.

AN INVENTORY of items of historical interest in Sheffield crafts and industries is being compiled by Mr. H. Raymond Singleton, director of Sheffield City Museums. It is hoped that eventually Sheffield will have a separate industrial museum covering all the aspects of the city's industry and that the drawing up of the inventory will prevent suitable items from being lost or going to other museums. Sheffield Junior Chamber of Commerce is co-operating in the project and has asked that anyone who knows of items with possible historical value and interest to send details for inclusion in the inventory.

THE CENTENARY of Sheffield's famous cricket ground at Bramall Lane has called attention to an historic score card which hangs in the plumbers' workroom at the works of Edgar Allen & Company, Limited, steelworks, Sheffield. It is the record of a cricket match played between Sheffield and Nottingham on the old Darnall ground in September, 1828, when Sheffield won the 100 sovereigns at stake by a "majority of 2, with 7 wickets to go down," as the 1828 scorer had it. The card was found in an old cottage now demolished, which stood on the site at present occupied by the offices of Edgar Allen.

THE FOLLOWING APPOINTMENTS have recently been made: Foundry Services Limited—Mr. R. D. Hume becomes deputy managing director and works director; Mr. R. A. Miller, director, with executive duties as sales manager; Mr. G. E. Cobby, director, with executive duties as chief accountant; Dr. D. V. Atterton, technical manager; and Mr. R. F. Boddey, deputy technical manager. Foundry Services (Overseas) Limited—Mr. R. A. Miller, director; Mr. G. E. Cobby, secretary; Mr. D. A. J. Patterson, manager, overseas manufacturing and export sales. Dr. K. Strauss and Mr. E. Weiss remain as chairman and managing director respectively of both concerns.

ENGLISH STEEL CORPORATION, River Don Works, Sheffield, will be illustrated in photographs to be displayed in Geneva, in August, at the international exhibition of the peaceful uses of atomic energy. The photographs will show the Corporation's steelmaking and engineering contributions to the development of the atomic energy programme in Britain. The works began making atomic energy plant in 1947, but it was not until early this year that it was made known in a bulletin of the Corporation that parts had been made for the first cyclotron at Harwell and for that at Liverpool University. The total weight of steel used for Harwell was 525 tons and for Liverpool 1,640 tons.

COMMENTING on the coal price increase, Sir Leslie Hollinghurst, chairman of the National Industrial Fuel Efficiency Service said that this was a challenge that industry could afford to accept. At first sight, an increase of 18 per cent. on industry's fuel bill, now standing at £200-£250 millions for coal alone, might seem a serious threat to the nation's power to compete in the export markets of the world. However, NIFES had found that there were few works in general industry where fuel consumption could not be reduced by 15 to 20 per cent. The increased costs of fuel could, therefore, be offset by savings. In order to help industry, the Service was increasing its engineering staff and was now ready to accept additional work in every area of the country.

UNITED STEEL COMPANIES, LTD., Sheffield, announce new additions to their engineering and metallurgical facilities at the Swinden Laboratories, Rotherham. The new facilities include three high-frequency electric steel-melting furnaces and an experimental hot-rolling mill. The furnaces are powered by a motor alternator driven by a motor running at 3,000 revs. per minute. Experimental ingots of five, 25 and 112 lb. can be produced. The main purposes for which the new hot-rolling mill is designed are: to roll ingots into bars from which specimens can be made for metallurgical examination; to assist in investigations into the manipulation of steel rolling; and to assist in the examination of problems arising in production mills.

BABCOCK & WILCOX, LIMITED, will be playing a prominent part in the commercial exhibition associated with the International Conference on the Peaceful Uses of Atomic Energy, to be held in Geneva during August. The firm's stand, which is one of the largest commercial exhibits, presents the theme of atomic-power development through the medium of steam in three sequences: past, present, and future. It shows how the company has, for three-quarters of a century, been intimately connected with the large-scale steam generation of electric power, and how the fund of knowledge, experience, and manufacturing techniques built up during the period are being applied to the problems of atomic power generation both at Calder Hall and on longer-term projects which include "packaged" and mobile power units.

AMONG RECENT INSTALLATIONS of radio-telephone equipment by Pye, Limited, Cambridge, is that supplied to Bonnington Castings, Limited, Edinburgh. This company's production of castings is rapidly growing and space has become a problem. To cope with the increased work they have had to take another works some two miles away, where all castings are now finished. This heavy daily movement has previously been carried out with eight contracted lorries, but the company are now buying new lorries to carry out this work themselves. By modern radio-control methods, they aim to carry their output from plant to plant much more efficiently than could ever be done before. Lorries returning empty from the finishing plant can now be directed to pick up incoming raw materials from the rail head.

DR. MARY ANDREWS, of Shatton, Bamford, Derbyshire, whose ancestors were once owners of Wortley Ironworks, near Sheffield, performed the re-opening ceremony of the forge of the ironworks, as an industrial museum, on July 9. It dates from the 18th century, and was part of the ironworks which made cannon balls in the Civil War. The plant was last worked by J. & B. Birdsell, of Leeds, and production ended in 1929. Sheffield Trades Historical Society has acquired the Top Forge together with help from private individuals and Samuel Fox & Company, Limited, Stocksbridge, which is the nearest steelworks. When funds are available it is hoped to restore two old water-driven tilt-hammers to working order. Colonel W. Midd'eton and Dr. J. M. Whittaker, Vice-Chancellor of Sheffield University, thanked Dr. Andrews for performing the re-opening ceremony.

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Raw Material Markets

Iron and Steel

Chief anxiety in the supply of raw materials to the foundry industry concerns the engineering and speciality foundries, many of which have received confirmation of a drastic cut in their supplies of the low- and medium-phosphorus irons due to the closure for relining and repairs of a large furnace. Most of these foundries have well-filled order-books and their prospects are good. But how and where to find sufficient pig-iron to fulfil these commitments is indeed a problem. Outputs of low- and medium-phosphorus irons have been inadequate for a long time and other producers will be unable to cover the cut in supplies caused by the closing of the furnace. Hematite is also scarce, although the position should be easier shortly because it is understood that a large furnace producing hematite will be put into blast by the end of this month.

Increased deliveries of the refined grades of pig-iron are being taken up, and there is also a heavy demand from English foundries for available supplies of Scotch foundry pig-iron. Inquiries for imported low-phosphorus pig-iron and hematite are more numerous, but supplies from abroad are scarce.

The jobbing foundries are mostly busy, while many of the light foundries are also well engaged, although those producing castings for domestic utensils are less active, the demand for gas cookers, refrigerators, etc., having been affected by the recent credit restrictions. The supply of high-phosphorus pig-iron to these foundries appears to meet current needs, but there is no margin. The demand for the better and heavier grades of cast-iron and machinery scrap is brisk; lighter scrap is more plentiful.

Foundry coke is coming forward fairly well, while ganister, limestone, and firebricks are plentiful.

There is little change to report in the position with the re-rollers. The steel semis recently received from home and overseas sources are being used up rapidly. Business is good for all the re-rollers' products. Home steelworks are sending forward regular supplies in either prime or defective material, but the quantities are not enough to satisfy needs. Apart from the shortage of raw materials, the re-rollers are also suffering from scarcity of labour, and this is restricting outputs.

Non-ferrous Metals

Figures issued by the British Bureau of Non-Ferrous Metal Statistics for May make a better showing than for April, when the intervention of the Easter holidays interfered with consumption to some extent. Broadly speaking, stocks were down and consumption up. In copper, stocks at May 31 were 58,546 tons, about 2,200 tons below the total at the end of April, while consumption of refined copper and scrap combined, at 54,404 tons, compared with 48,146 tons in the previous month.

Consumption of virgin zinc in May was 21,455 tons and of secondary metal 7,782 tons, making 29,237 tons in all. Stocks of virgin zinc dropped from 53,573 tons at April 30 to 50,447 tons at May 31. In lead, stocks, at 38,760 tons, showed a sharp drop on the April figure of 45,226 tons, while consumption of all grades advanced to 31,092 tons from the April figure of 28,656 tons. Stocks of tin fell by 284 tons to 3,742 tons, but consumption, at 1,818 tons, was 77 tons up.

Keen interest developed in the tin market last week, for it now seems probable that Indonesia will ratify the tin agreement and enable the scheme to come into force in the fairly near future. Most of the buying pressure was in the cash position, which gained no less than £23 to reach £752, while three months put on £18 to £744 10s. The backwardation widened to £7 10s., for stocks of concentrates in this country at the moment are rather low. On Monday the final price touched £765 cash, the highest for many months.

Zinc held back somewhat, but July closed 5s. better and October 15s.; both positions were quoted level at £91 15s. Lead advanced for the second week running to close at £106 15s. prompt and £106 5s. forward, with demand in this county and in the United States sustained. Copper was strong on scarcity prospects due to the US strike, closing £10 up for cash and £7 10s. better for three months.

Official metal prices were as follow:—

COPPER, Standard—*Cash:* July 14, £346 to £347; July 15, £348 10s. to £349 10s.; July 18, £354 to £355; July 19, £352 to £353; July 20, £350 to £351.

Three Months: July 14, £339 10s. to £340; July 15, £341 to £342; July 18, £346 to £347; July 19, £345 10s. to £346; July 20, £342 to £343.

TIN, Standard—*Cash:* July 14, £744 to £746; July 15, £746 10s. to £747; July 18, £758 to £759; July 19, £763 to £764; July 20, £758 to £759.

Three Months: July 14, £739 to £740; July 15, £741 to £742; July 18, £751 to £752; July 18, £754 to £755; July 20, £750 to £751.

LEAD—*First half July:* July 14, £105 10s. to £105 15s. *Second half July:* July 15, £106 5s. to £106 10s.; July 18, £106 15s. to £107; July 19, £106 10s. to £106 15s.; July 20, £106 15s. to £107.

First half October: July 14, £105 5s. to £105 10s. *Second half October:* July 15, £105 15s. to £106; July 18, £106 10s. to £106 15s.; July 19, £106 5s. to £106 10s.; July 20, £106 5s. to £106 10s.

ZINC—*First half July:* July 14, £91 to £91 5s. *Second half July:* July 15, £91 5s. to £91 10s.; July 18, £91 15s. £92; July 19, £91 15s. to £92; July 20, £91 10s. to £91 15s.

First half October: July 14, £91 to £91 10s. *Second half October:* July 15, £91 5s. to £91 10s.; July 18, £91 17s. 6d. to £92; July 19, £91 12s. 6d. to £91 15s.; July 20, £91 10s. to £91 15s.

Metal and Mould Research on Steel Castings—II

(*Continued from page 70*)

some of their experimental results; and to Mr. Basil Gray, of English Steel Corporation, Limited, for a similar privilege. Thanks are also due (from Mr. J. M. Middleton and Mr. J. White) to Mrs. P. Williams and Miss J. Goodison, who performed the numerous chemical analyses and other tests on the clays.

The Authors finally wish to acknowledge both the permission granted by the British Steel Castings Research Association to publish the information contained in this Paper and also the interest and encouragement shown by Mr. J. F. B. Jackson, former director of the Association.

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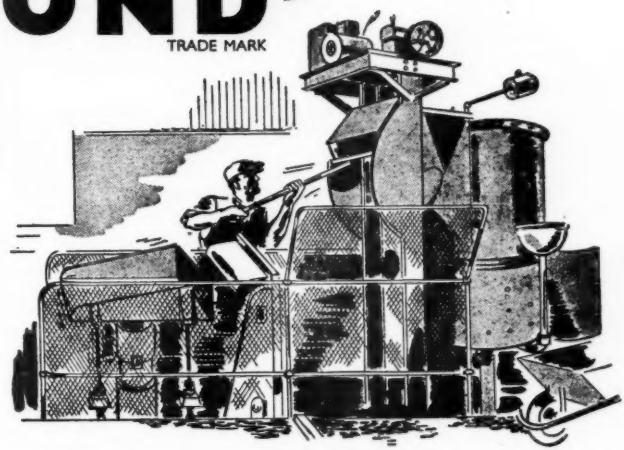

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Current Prices of Iron, Steel, and Non-ferrous Metals

(Delivered unless otherwise stated)

July 20, 1955

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £15 12s. 0d.; Birmingham, £15 5s. 3d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £17 13s. 9d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si), d/d within 60 miles of Stafford, £18 9s. 3d.

Scotch Iron.—No. 3 foundry, £18 2s. 3d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £20 4s. 0d.; South Zone, £20 6s. 6d.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £21 1s. 6d.; South Zone, £21 4s. 0d.

Hematite.—Si up to 2 per cent., S. & P. over 0.03 to 0.05 per cent.:—N.-E. of England (local iron), £18 2s. 6d.; Scotland (Scotch iron), £18 9s. 0d.; Sheffield, £19 7s. 6d.; Birmingham, £19 14s. 6d.; Wales (Welsh iron), £18 9s. 0d.

Basic Pig-iron.—£15 15s. 6d. all districts.

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered)

Ferro-silicon (6-ton lots and over).—45 per cent., Si, £40 15s. 0d., scale 15s. per unit; 75 per cent., Si, £63 0s. 0d., Si, scale 16s. per unit.

Ferro-vanadium.—50/60 per cent., 23s. 8d. to 25s. 0d. per lb. of V.

Ferro-molybdenum.—65/75 per cent., carbon-free, 11s. 0d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, £230 0s. 0d. per ton; 38/40 per cent., £279 0s. 0d. per ton.

Ferro-tungsten.—80/85 per cent., 17s. 2d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 20s. 2d. per lb. of W.

Ferro-chrome (6-10 ton lots).—4/6 per cent. C, £83 0s. 0d. to £86 0s. 0d., basis 60 per cent. Cr, scale 25s. 0d. per unit; over 6 per cent. C, £81 0s. 0d. to £84 0s. 0d., basis 60 per cent. Cr, scale 24s. 0d. per unit; 2 per cent. C,* 1s. 11½d. per lb. Cr; 1 per cent. C,* 2s. 0d. per lb. Cr; 0.15 per cent. C,* 1s. 11d. to 2s. 1d. per lb. Cr; 0.10 per cent. C,* 1s. 11d. to 2s. 2d. per lb. Cr; 0.06 per cent. C,* 2s. 3d. per lb. Cr.

Metallic Chromium.—98/99 per cent., 7s. 0d. to 7s. 6d. per lb.

Metallic Manganese.—93/95 per cent., carbon-free, £249 0s. 0d. per ton; 96/98 per cent., £269 0s. 0d. per ton.

Ferro-columbium.—60/75 per cent., Nb + Ta, 52s. 6d. to 70s. 0d. per lb., Nb + Ta.

Ferro-manganese (home).—78 per cent., £53 17s. 6d.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—BASIC: Soft, u.t., £25 5s. 0d.; tested, 0.08 to 0.25 per cent. C, £26 5s. 0d.; hard (0.41 to 0.60 per cent. C), £27 10s. 0d.; silico-manganese, £34 10s. 0d.; free-cutting, £29 6s. 6d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £32 17s. 0d.; silico-manganese, £34 10s. 0d.

* Average 68-70 per cent.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £29 13s. 6d.; basic, hard, over 0.41 up to 0.60 per cent., C, £30 16s. 0d.; acid, up to 0.25 per cent. C, £33 15s. 0d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £31 1s. 6d.; boiler plates (N.-E. Coast), £33 11s. 6d.; floor plates (N.-E. Coast), £32 10s. 6d.; sectional material, N.-E. Coast, £29 4s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested, £31 19s. 6d.; flats, 5 in. wide and under, £31 19s. 6d.; hoop and strip, £33 1s. 6d.; uncoated strip mill coils, hot rolled, under 3mm. to 12g., £34 5s. 0d.; black sheets (hand mill), 17/20 g., £43 13s. 6d.; galvanized corrugated sheets, 24 g., £55 4s. 0d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £54 7s. 9d.; nickel-chrome, £76 7s. 9d.; nickel-chrome-molybdenum, £86 8s. 6d.

NON-FERROUS METALS

Copper.—Cash, £350 0s. 0d. to £351 0s. 0d.; three months, £342 0s. 0d. to £343 0s. 0d.; settlement, £351 0s. 0d.

Copper Tubes, etc.—Solid-drawn tubes, 3s. 4⅛d. per lb.; rods, 396s. 3d. per cwt. basis; 20 s.w.g., 429s. 6d. per cwt.

Tin.—Cash, £758 0s. 0d. to £759 0s. 0d.; three months, £750 0s. 0d. to £751 0s. 0d.; settlement, £759 0s. 0d.

Lead (Refined Pig).—Second half July, £106 15s. 0d. to £107 0s. 0d.; second half October, £106 5s. 0d. to £106 10s. 0d.

Zinc.—Second half July, £91 10s. 0d. to £91 15s. 0d.; second half October, £91 10s. 0d. to £91 15s. 0d.

Zinc Sheets, etc.—Sheets, 15 g. and thicker, all English destinations, £122 5s. 0d.; rolled zinc (boiler plates), all English destinations, £120 10s. 0d.; zinc oxide (Red Seal), d/d buyers' premises, £103 0s. 0d.

Brass Tubes, etc.—Solid-drawn tubes, 2s. 8½d. per lb.; rods, drawn, 3s. 5⅞d.; sheets to 10 w.g., 345s. 3d. per cwt.; wire, 3s. 3½d.; rolled metal, 331s. 0d. per cwt.

Brass (Brazing).—BS1400, B3 (65/35), £214; B6 (85/15), —; BS249, —

Brass (High Tensile).—BS1400, HTB1 (30 tons), £270; HTB2 (38 tons),—; HTB3 (48 tons),—.

Gunmetal.—RCH, 3/4 per cent. tin, —; BS1400, LG3 (85/5/5/5), £295; LG3 (86/7/5/2), £306; G1 (88/10/2/½), £373; (88/10/2/1), £364.

Phosphor Bronze.—BS1400, PB1 (AID released), £388 per ton.

Phosphor Bronze Strip, etc.—Strip, 483s. 0d. per cwt.; sheets to 10 w.g., 506s. 6d. per cwt.; wire, 4s. 11½d. per lb.; rods, 4s. 3½d.; tubes, 4s. 1½d.; chill cast bars: solids 4s. 4d. cored 4s. 5d. (CHARLES CLIFFORD, LIMITED.)

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × 0.056, 4s. 1½d. per lb.; round wire, 10g. in coils (10 per cent.), 4s. 6d.; special quality turning rod, 10 per cent., ½ in. dia., in straight lengths, 4s. 5d. All prices are net.

Other Metals.—Magnesium, ingots, 2s. 3d. per lb. Antimony, English, 99 per cent., £210 0s. 0d. Quicksilver, ex-warehouse, £108 0s. 0d. Nickel, £519 0s. 0d. Aluminium, ingots, £171 0s. 0d.; aluminium bronze (BS1400), AB1, £343; AB2, £352. Solder, brazing, BS1845, 2s. 10d. lb.; granulated. 3s. 2d. lb.

New Patents

(Copies of complete specifications are obtainable from the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, London, W.C.2, price 3/-.)

731,038. Dow Chemical Company, Delaware, U.S.A. Improved apparatus for die-casting. It employs a piston operating in a heated "shot" cylinder for forcing molten metal through a gooseneck into a die, where the casting is made.

731,237. Josef Jacobs, 1, Amerikastrasse, Cuxhaven, Germany.

A process for the manufacture of cast iron or steel shot having a carbon content of less than 3 per cent. The cast iron is melted in the cupola furnace and is alloyed after being run off in the liquid state, with liquid steel. The alloy so obtained is then sprayed into water in the usual ways.

731,310. Lorenzo Ferrari, Viale Palazzi, N.3/11, Genoa, Italy.

An improvement in the method of, and apparatus for, making moulds. In this method a metallic mould is formed by heating a metallic body to forging temperature and briefly impressing a die into the heated body.

731,324. Enn Vallak, Grythyttan, Sweden.

Chill moulds for casting steel or similar metals, and sink-head boxes for them. The sink-head box is of a combustible or charrable material which during casting is situated in or on a chill mould so as to surround the ingot. The chill mould has passages or apertures to bleed off the gases caused by the combustion or charring of the walls of the sink-box head.

731,445. Rolls-Royce Limited, Nightingale Road, Derby.

A method of forming a shell mould around an expendable pattern. The pattern is dipped alternately in an acid and in an alkaline solution of soluble silicate in which a finely ground refractory material is suspended. Each dipping is followed by the application of a stucco material to the wet mould, until the desired thickness is obtained.

731,741. J. W. and C. J. Phillips, Limited, 144, Pomeroy Street, New Cross, London, S.E.14, and Charles Haylock, 5, Hambro Avenue, Hayes, Middlesex.

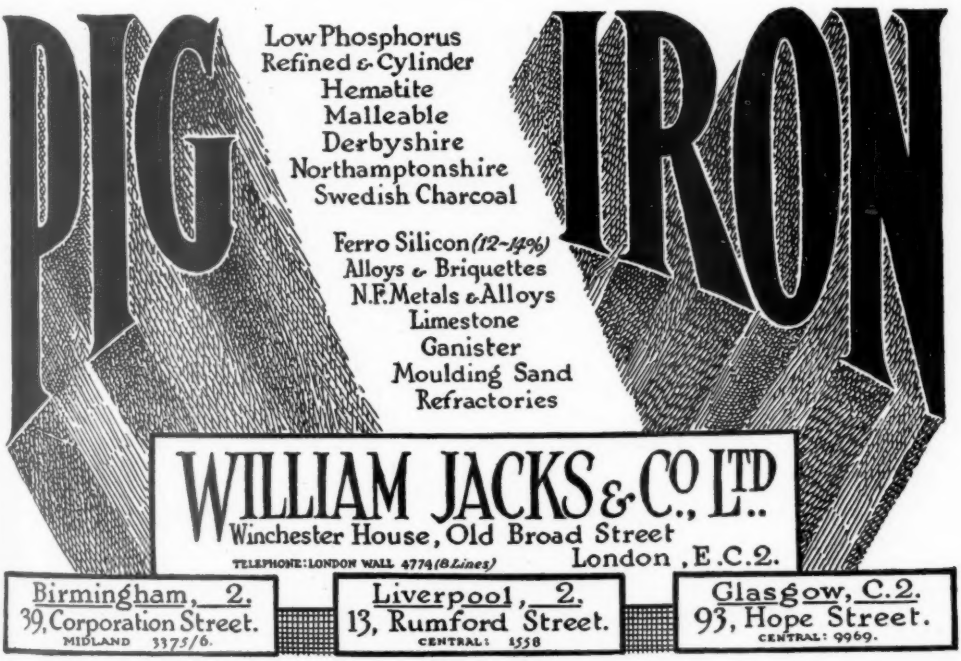
An improved fillet for use in patternshops which is preferably made of extruded plastic. It is of roughly triangular section with a groove at the apex of the triangle, extending longitudinally of the fillet to serve as a pocket for the adhesive by which the fillet may be secured in position.

731,825. A. S. Beech, and Foundry Equipment, Limited, Linslade Works, Leighton Buzzard, Beds.

A bucket-type elevator for foundry sands. Each bucket has a flap in the form of a false bottom. The flaps are pivoted to move freely within the bucket when empty. When the filled bucket is inverted, the flaps swing with the load under both centrifugal and gravitational force until the tip of the flap is in line with the front edge of the bucket. This ensures clearing of the bucket of sticky sand which under other methods does not easily come out.

731,984. Erwin Buhrer, 117, Alpenstrasse, Schaffhausen, Switzerland.

This patent relates to an apparatus for gripping a moulding flask during separation of mould from the pattern. The holding points of the device are so distributed on the moulding flask and the size of the gripping forces are such that they balance each other.



CLASSIFIED ADVERTISEMENTS

PREPAID RATES: Twenty words for 5s. (minimum charge) and 2d. per word thereafter. Box Numbers 2s. extra (including postage of replies).

Advertisements (accompanied by a remittance) and replies to Box Numbers should be addressed to the Advertisement Manager, Foundry Trade Journal, John Adam House, 17/19, John Adam Street, Adelphi, London, W.C.2. If received by first post Tuesday advertisements can normally be accommodated in the following Thursday's issue.

SITUATIONS WANTED

FOUNDRY EXECUTIVE (32) requires management position. Graduate metallurgist, foundry apprenticeship, with excellent experience of light, medium and heavy carbon and high alloy steel casting production. Good knowledge of melting practice, methods, plant layout, etc., and fully experienced in all modern developments. Energetic and progressive. Salary important but secondary to future prospects. Box FE385, FOUNDRY TRADE JOURNAL.

NON-FERROUS FOREMAN. Skilled moulder, knowledge in all classes of foundry practice. Accustomed to full control. Experienced in floor, bench, plate and machine moulding. Training of unskilled labour. Box NF389, FOUNDRY TRADE JOURNAL.

EXPERIENCED FOUNDRY MANAGER/FOREMAN, grey or malleable, desires post Midlands. 15 years' executive, jobbing or mechanisation, costing, rate fixing. Practical technical.—Box EF392, FOUNDRY TRADE JOURNAL.

FOUNDRY WORKS MANAGER, age 45 (practical man), 18 years' managerial experience, seeks position. Sound experience in modern methods of production, grey, malleable and chilled iron, including shell moulding. M.I.B.F.—Box FW391, FOUNDRY TRADE JOURNAL.

EXPERIENCED FOUNDRY / SALES MANAGER (44), M.I.B.F., life experience trade, desires engagement Representative reputable firm. Cover Wales, Salop, Midlands. Car essential. Salary secondary. Commence immediately. References. — Box KC393, FOUNDRY TRADE JOURNAL.

WORKS ENGINEER seeks new top level appointment U.K. or overseas (age 35). Comprehensive experience modern maintenance/development/mechanised foundries, associated plant, machine shops. Good background and qualifications.—Box WE394, FOUNDRY TRADE JOURNAL.

FOUNDRY FOREMAN (24), G.S. educated to H.S.C. standard. Practical training mech. G.I. foundry, D.O., patt. shop and laboratory. Experience control non-ferrous and shell. Will undertake complete retraining anywhere on results basis.—Box FF398, FOUNDRY TRADE JOURNAL.

ADVERTISER in executive position Manchester, with 50 years' experience Scrap Trade, is being placed on half-time 1st September. Seeks opening where remainder of week can be filled. Box AI388, FOUNDRY TRADE JOURNAL.

EXPERIENCED FOUNDRY FOREMAN desires change. Extensive experience jobbing and mechanical production cupola, sand control. Estimating. Ferrous and non-ferrous. Box EF378, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order, 1952.

METALLURGISTS.

REQUIRED for research and development work on magnesium base alloys. Preference given to men with good honours degree, but other applications will be considered. Permanent appointment with contributory pension and life assurance. Apply stating reference FJ.JL7, age and details of qualifications and experience to SECRETARY, Magnesium Elektron Limited, P.O. Box No. 6, Lumm's Lane, Clifton Junction, Swinton, near Manchester.

BRASS Gravity Die Casting TECHNICIAN required for a growing Foundry specialising in the production of Plumbers' Brass-ware. Applicant must have a complete knowledge of this branch of the foundry trade and be capable of organising and maintaining a high rate of production. This is a position for a very energetic and determined personality. Age not exceeding 40. Salary in accordance with experience. Contributory pension scheme. Southern area.—Box BG326, FOUNDRY TRADE JOURNAL.

FOUNDRY ENGINEER wanted. Immediate duties will be mainly concerned with the layout of new Mechanised Plant, but would later extend to the control of works maintenance service. Salary in accordance with ability, and a generous pension scheme.—Apply in writing, giving details of previous experience, etc., to SHOTTON BROS., LTD., Manchester Street, Oldbury.

LARGE engineering works ten miles north of Manchester have a vacancy for a WORKING FOREMAN to commence early September for the NON-FERROUS department of their foundry. The post offers plenty of scope for advancement to a man of initiative with ability to organize and manage the department with a minimum of supervision. Applications will be treated in strictest confidence which should state age, experience, full details of present employment and an idea of remuneration required and should be addressed to Box LE400, FOUNDRY TRADE JOURNAL.

ASSISTANT FOUNDRY MANAGER for specialist work in aluminium sand foundry (Southern England). Experience of large repetition castings, and some knowledge of metallurgy preferred. House available. Box AF381, FOUNDRY TRADE JOURNAL

SITUATIONS VACANT—contd.

METALLURGICAL CHEMIST, aged 25-30 years, required to take charge of laboratory and technical control in foundry producing Whiteheart Malleable and Grey Iron. General ability is an important as technical qualifications. Applications stating age, experience, and salary required, to :—BAGSHAWE & Co. Ltd., Dunstable, Beds.

APPLICATIONS are invited for the position of Fettling and Finishing SHOP FOREMAN in Blackheart Malleable Iron Foundry handling approximately 100 tons per week General Engineering Castings. The position carries a good salary and bonus, and the successful applicant would be entitled to participate in Staff Pension Scheme. Write: Box AA377, FOUNDRY TRADE JOURNAL.

FOUNDRY.—TIME STUDY AND METHODS ENGINEER required, capable of Estimating, Designing Pattern Layouts, also Time and Motion Study all Departments connected with the foundry. Applicants should have had experience in Repetition Foundry and be capable of working on own initiative. This position holds excellent prospects for the right man. —Please give full particulars, in confidence, of past experience and salary required, to Box FT366, FOUNDRY TRADE JOURNAL.

ASSISTANT FOUNDRY MANAGER required by mechanised grey and malleable ironfounders, Wolverhampton area. Applicants should have good knowledge of machine moulding methods and ability to control labour. Knowledge of cupola and sand control is essential and preference will be given to applicant having been trained in method study procedure. Good progressive position for right man. Apply giving details of age and experience to Box AF375, FOUNDRY TRADE JOURNAL.

CHIEF DRAUGHTSMAN required, having experience of General Engineering and Plant Layout; experience of Jig and Tool design advantageous but not essential. Applicants should apply, in writing, stating age, past experience, and salary required to: THE SECRETARY of The North British Steel Foundry Limited, Balbardie Steel Works, Bathgate.

METAL CONTROLLER wanted for iron foundry. Must be fully experienced in operation and control of cupolas. CLANCEY, Belle Vale, Halesowen.

PATTERN SHOP FOREMAN required to take over supervision of shop. Present foreman due to retire. Applicants must have had previous experience in supervising pattern production for modern production requirements, estimating, and rate fixing. House available after satisfactory probationary period.—Applications, stating age, experience, and salary required, to: PERSONNEL MANAGER, Marshall Sons & Co. Ltd., Britannia Works, Gainsborough.